AIR&SPACE

Smithsonian · February/March 1989

$3.50

U.S. and Soviet artists bring space down to Earth

THE ROMAN EMPIRE AND MILITARY AIRLIFT

Perhaps the most remarkable thing about the Roman Empire was that, at its greatest geographic extension, its security was assured by a mere thirty legions. From Scotland to Egypt no more than 180,000 regular troops kept the Empire in tranquility.

The key to this manpower-efficient defense was the metalled road.

Metalled roads provided a great logistic advantage over ordinary dirt highways, which could not support the traffic of a marching legion (around 6,000 troops and a like number of animals). Even in dry weather, movement was restricted to about twelve miles per day. In rain and snow, dirt roads were churned into

Roman road at Timgad, Algeria

quagmires, and movement stopped altogether.

But on their extensive network of paved, engineered roads, the Roman troops could march thirty miles a day—in all weather. Legions could be quickly shuttled around the empire to respond to unrest in one province, or the invasion of another. In this way, Rome could afford a much smaller defense establishment than the geographic size of her empire would suggest.

In the late 20th century this lesson of strategic and tactical mobility is still apt. For the United States, with our global commitments, our Roman roads are our airlift fleet.

Presently that logistic potential is adequate to respond to small scale crises around the world. But in the event of a major outbreak overseas, and given the strength of our current airlift fleet, there has been some debate as to our ability to protect our worldwide interests.

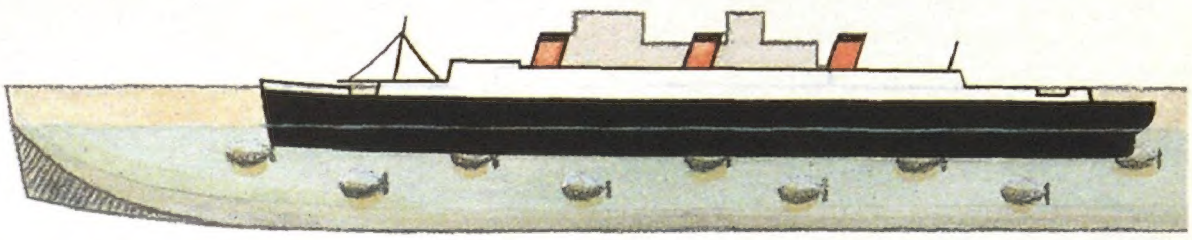
Flexibility is critical to an efficient defense. Julius Caesar understood it. All Romans understood it. It was the primary reason for their paved roads. Without them, the Roman Empire would not have lasted as long as it did, for the mere knowledge that legions could be on the scene within weeks was usually sufficient to keep the peace.

In the near future, the knowledge that overwhelming American force might be on the scene within hours would give pause to potential enemies. And that, in the final analysis, would be the most efficient defense of all.

February/March 1989
Volume 3, Number 6

AIR&SPACE
Smithsonian

Contents



AIR & SPACE/Smithsonian (ISSN 0886-2257) is published bimonthly by the Smithsonian Institution, 900 Jefferson Drive, Washington, DC 20560. Subscription price: $18 a year in U.S. possessions, $24 elsewhere. Eighty-five percent of dues is designated for magazine subscription. Single-copy price: $3.50. Second-class postage paid at Washington, DC, and additional entry points. Editorial offices: National Air and Space Museum, Washington, DC 20560. Advertising and circulation offices: 420 Lexington Ave., New York, NY 10170. Members: Address all subscription correspondence and change-of-address information to P.O. Box 53261, Boulder, CO 80322-3261. Postmaster: Send address changes to *AIR & SPACE/Smithsonian*, P.O. Box 53261, Boulder, CO 80301-3261.

Cover: *Andrey Konstantinovich Sokolov painted the Salyut space station as he imagined it in orbit.*

Calling All Stars

In my three decades in the planetarium profession, the three questions I am asked most by the general public are: Where are the best seats? How much did that thing in the center cost? Is there intelligent life out there?

The first two are easy. In the National Air and Space Museum's Albert Einstein Planetarium, all the seats are good, and the Zeiss model VIa planetarium projector cost us nothing. It was a bicentennial gift to the people of the United States from the Federal Republic of Germany. (You can buy one of your very own today for something on the order of $2 million.)

Many great minds have speculated about the third question for centuries, perhaps millennia. Obviously, we still have no answer. For this and other reasons, I have always resisted suggestions to do a planetarium show on extraterrestrials. Nevertheless, a number of compelling arguments have convinced me that this is a good time for the Einstein Planetarium to present "Calling All Stars," which opens this March.

In just three years, the nation—and with it the Smithsonian Institution—will be commemorating the 500th anniversary of Columbus' famous voyage. NASM will be mounting a major exhibit—"Where Next, Columbus?"—which will focus on the future of humankind in space and will inevitably deal in part with the ET question. The planetarium's "Calling All Stars" will provide the celebration with an appropriate prologue.

The idea of a universe teeming with life, some of it in the form of intelligent beings we could relate to, is an attractive one for many of us. For years, fiction writers have taken this idea as a matter-of-fact premise for countless interstellar adventures, many of the better ones addressing important issues eminently relevant to life right here on Earth. I suspect that very few of their readers have trouble separating fact from fiction.

But there is an alarming trend relentlessly fed and encouraged by an entirely different genre of supposedly *non*-fiction writers. Seen at their worst at every supermarket checkout stand, they regale their readers with such nonsense as reported abductions of Earthlings by extraterrestrial UFOs, mysterious events in the mythical Bermuda triangle, and sightings of B-25s on the moon. We see notoriously *un*documented film and television "documentaries" purporting to show that ETs have been intervening in human affairs for centuries. More than 10 times as many titles of this genre are for sale in most bookstores as there are carefully researched and documented factual books written by those few authors competent, responsible, and patient enough to do the hard work required to investigate such claims thoroughly.

The necessarily inconclusive speculations of former times are less intriguing to me than are recent scientific developments. We have an enormous advantage over our forebears who wondered about ETs: we are acquiring the scientific and technological wherewithal to search for an answer. As those in the biological sciences acquire an ever more detailed understanding of how living organisms work, planetary scientists study mountains of data from space probe encounters with planets and satellites in the solar system. Meanwhile, astronomers and astrophysicists, using exciting new tools and techniques to observe other stars, have good reason to believe that many of them are suns similar to our own—complete with planets. Whether these planets harbor life is the next most obvious question. But patience is a necessity: the universe is a very large place for life to hide.

At the Harvard-Smithsonian Oak Ridge Observatory in Massachusetts, an 84-foot dish-shaped antenna continuously sweeps the heavens. Extremely sensitive receivers monitor millions of radio frequencies while a boredom-proof computer searches through the interstellar radio hash for anything out of the ordinary—just one single, unmistakable signal from some extraterrestrial intelligence . . . .

—James H. Sharp is chief of the National Air and Space Museum's Albert Einstein Planetarium.

AIR&SPACE
Smithsonian

Secretary of the Smithsonian Institution
Robert McC. Adams

Editor
George C. Larson

Managing Editor
Tom Huntington

Senior Editor
Linda Musser Shiner

Picture Editor
Lee Battaglia

Departments Editor
Patricia Trenner

Associate Editors
Karen Jensen
Perry Turner

Design Consultation
Phil Jordan
Carolyn McIntyre
Julie Schieber

Associate Editor/Pictures
Caroline Sheen

Assistant Editor
Shelia Perry Brannum

Editorial Assistant
Diane Tedeschi

Founder
Walter J. Boyne

Publisher
Joseph J. Bonsignore

Advertising
Louis C. Kolenda, Director
Charles R. Berry
Valerie Hinckley

Circulation
Gale Page
Margaret Moore

Administration
Carey O. Randall, Associate Publisher

Business Manager
Diana Barclay

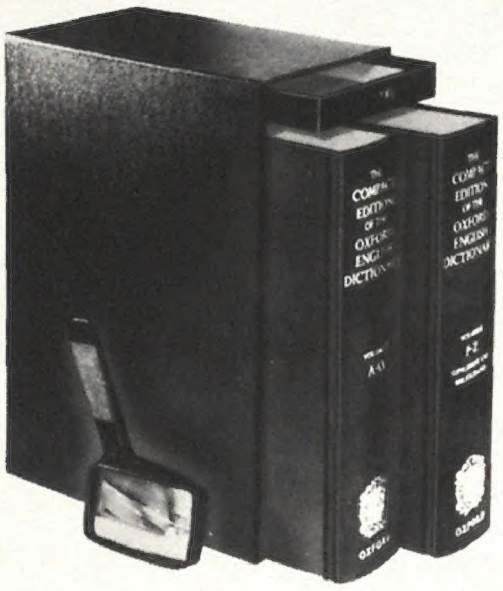
Production Manager
Sarah D. Kingsley
Kristine Roberts

Consultant
Anne Keating, Senior Consultant

Choose one of these fine works and save over $290.

You simply agree to buy 4 books within the next 2 years.

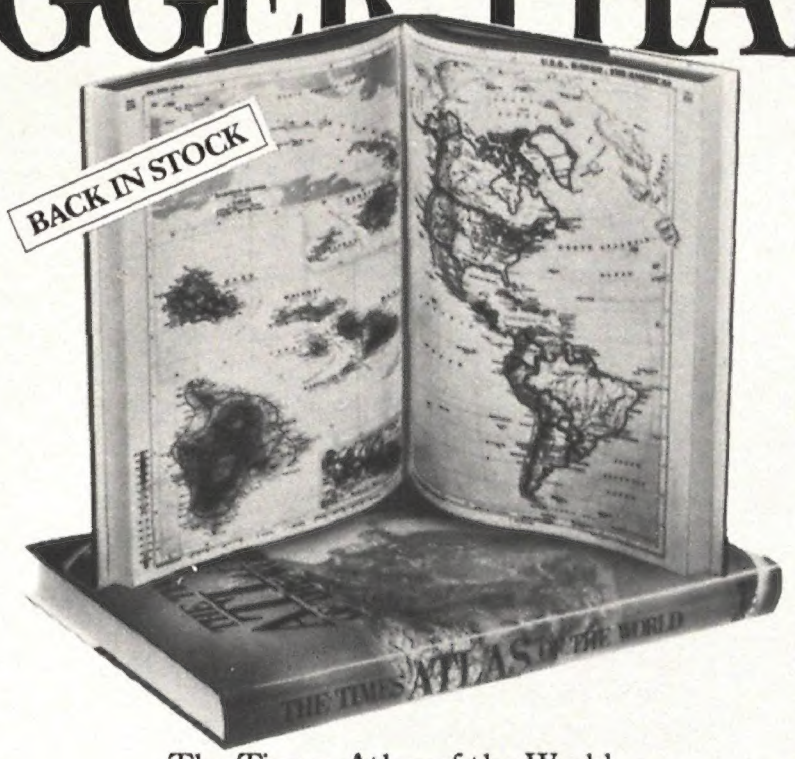
BARGAINS DON'T GET ANY BIGGER THAN THIS.



The Compact Edition of The Oxford English Dictionary

for **$27.95** (Pub. price $195)

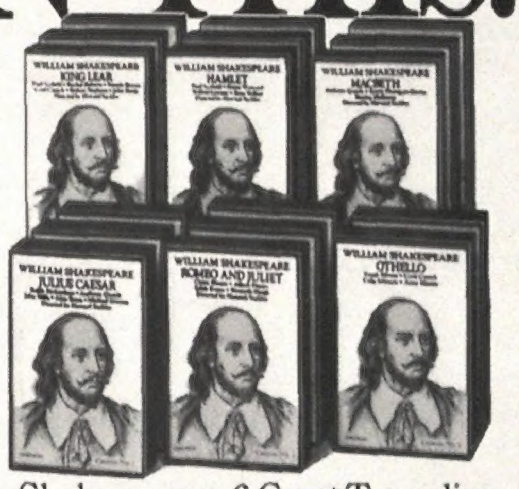
"The most complete, most scholarly dictionary of the English language"—*The Christian Science Monitor.* Through photoreduction, the original 13-volume set has been reproduced in this two-volume *Compact Edition.* A Bausch & Lomb magnifying glass is included.



The Times Atlas of the World Seventh Comprehensive Edition

for **$29.95** (Pub. price $149.95)

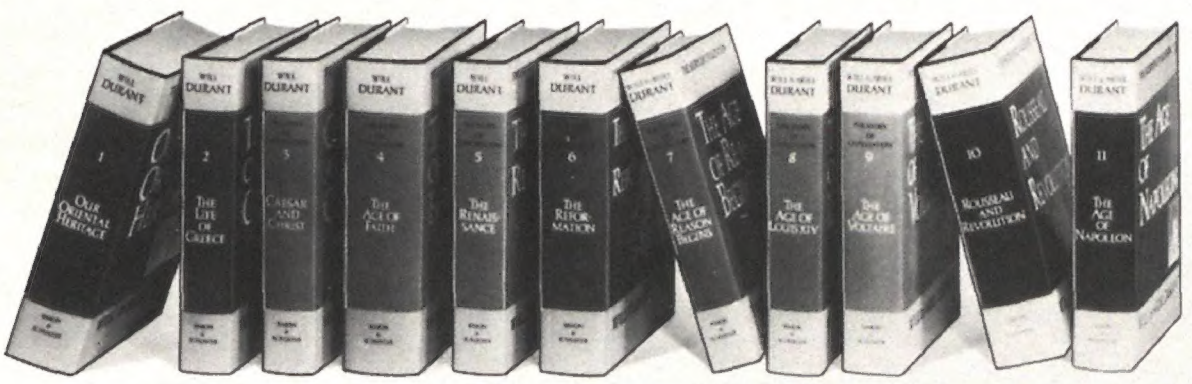
"The best atlas now available in English."—*The New York Times.* The only atlas printed in 8 colors for clear reading of geographic and political features. This volume contains 292 pages of color maps and a 277-page index with over 200,000 entries which include longitude and latitude—a feature not offered in other atlases. Size: 18″ x 12″ Pages: 520.



Shakespeare: 6 Great Tragedies

for **$19.95** (List prices total $179.60)

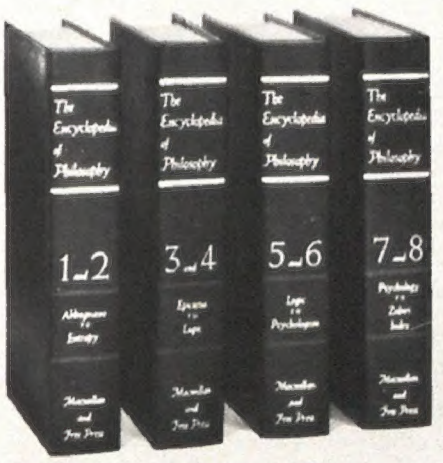
Book-of-the-Month is proud to present 6 of Shakespeare's greatest tragedies: *Hamlet, King Lear, Macbeth, Othello, Romeo and Juliet* and *Julius Caesar.* Paul Scofield, Ralph Richardson, Albert Finney, Dame Edith Evans, Claire Bloom, John Mills and many more of England's most gifted Shakespearean actors perform memorably in complete readings of each play. 17 cassettes in all.



The Story of Civilization by Will and Ariel Durant

for **$29.95** (Pub. prices total $335.45)

For almost half a century Will and Ariel Durant traced the continuity of world history—the religions and philosophies, the political and economic tides, the arts and sciences, the customs and conquests—to show the foundations of society today. A Book-of-the-Month Club exclusive for almost 50 years, the Durants' illustrated masterwork is history come alive.



The Encyclopedia of Philosophy

for **$24.95** (Pub. price $225)

Regarded as the most comprehensive encyclopedia of philosophy ever published, this superb set—compiled in collaboration with the world's foremost philosophers—encompasses aspects of ancient, medieval, modern, Eastern and Western thought. The four volumes represent an essential aid for students and a rewarding reference source.

Facts About Membership. As a member you will receive the *Book-of-the-Month Club News*® 15 times a year (about every 3½ weeks). Every issue reviews a Selection and more than 150 other books, which are carefully chosen by our editors. If you want the Selection, do nothing. It will be shipped to you automatically. If you want one or more other books—or no book at all—indicate your decision on the Reply Form and return it by the specified date. *Return Privilege:* If the *News* is delayed and you receive the Selection without having had 10 days to notify us, you may return it for credit. *Cancellations:* Membership may be discontinued, either by you or by the Club, at any time after you have bought 4 additional books. Join today. With savings and choices like these, Book-of-the-Month Club is where book lovers belong.

BOOK-OF-THE-MONTH CLUB®

Book-of-the-Month Club, Inc., P.O. Box 8803, Camp Hill, PA 17011-8803 **A003-2**

Check one box only.

- ☐ 923. Shakespeare (17 cassettes) **$19.95**
- ☐ 905. Compact OED **$27.95**
- ☐ 946. Times Atlas of the World **$29.95**
- ☐ 913. The Story of Civ. **$29.95**
- ☐ 917. Ency. of Philosophy **$24.95**

Please enroll me as a member of Book-of-the-Month Club and send me the item I have checked at left, billing me for the appropriate amount, plus shipping and handling charges. I agree to buy four more books during the next two years. A shipping and handling charge is added to each shipment.

Name_____ **9-64**

(Please print plainly)

Address_____ Apt._____

City_____

State_____ Zip_____

Prices shown are U.S. prices. Outside the U.S. prices are generally higher. All orders subject to approval.

Letters

Totaled

You erroneously reported that the National Air and Space Museum's X-15 flew 199 missions (Update, December 1988/January 1989). It actually flew 81. The no. 2 aircraft, now on display at the Air Force Museum, flew 53 missions. The third vehicle was destroyed on its 65th flight, killing Air Force Major Michael J. Adams. Thus, the 199 missions were the *total* for the three examples built. This does not include 127 airborne aborts or scheduled captive flights that terminated with the X-15 attached to the B-52 mothership.

The 200th mission was attempted several times with the no. 1 ship in December 1968, but bad weather prevented its completion.

Richard A. Boulais
Glendale, Arizona

Bringing Up More About Betsy

In "Bringing Up Betsy" (December 1988/January 1989), Frank Winter neglected to mention one other X-1 airplane that was powered by the RMI 6000C4 rocket engine and fueled by the turbopump-type propellant system. The third X-1, shown in the picture on page 82, was also fitted with this propulsion system. The turbopump was not part of the engine but was a component of the airplane propellant storage and feed system. This airplane was destroyed during test operations at Edwards Air Force Base while jettisoning its propellants on the ground.

Incidentally, the Bell X-2 aircraft also used a hydrogen peroxide-driven turbine pump to inject the water-alcohol and liquid oxygen propellants into its Curtiss-Wright XLR-11 RM-5 rocket engine.

Martin A. Snyder
Fremont, California

Better Visibility

In her excellent article "On the Road to Io" (December 1988/January 1989), Thelma Chang states that "even from the most powerful telescopes, Io appears as a mere pinpoint of light." I feel this implies that an observer cannot see its disk; that is, it does

"The White House is on the phone. They want to know where you put the keys to Air Force One."

not appear to have any diameter. This is not true. Even in an amateur astronomer's small six-inch telescope, the Galilean moons can be seen as round disks, although very small ones. Professional telescopes are able to show the satellites as larger disks, but the blurring effect of Earth's atmosphere limits the amount of visible details.
John Holtz
Glenshaw, Pennsylvania

In Yeager's Defense

While Patricia Trenner's review of Yeager's *Press On!* (December 1988/January 1989) will not win any great prizes, it was okay, I guess, until that last cheap shot that finally and fully verified her indifferent and cursory interest in the whole review.

That comment was patronizing, unkind, uncalled-for, unneccessary, and in poor taste. Yeager deserves better. One may easily have disdain for the contents of a book without having to demean the author.
A. Scott Crossfield
Herndon, Virginia

Patricia, what do you have against Chuck Yeager?
J.C. Luis
Stockton, California

What Did Ike Like?

In "No Joystick in the White House?" (October/November 1988) Carl Posey states that President Eisenhower received his certificate of competency in a Stearman PT-1. The PT-1 was designed and manufactured by Reuben H. Fleet's Consolidated Aircraft Corporation in Buffalo, New York. The Husky PT-1 served as the U.S. Army's primary trainer from 1925 to 1937.

It is more likely that President Eisenhower received his certification in a Stearman PT-13. This aircraft was flown in the Philippines in 1939.
Cynthia Watkins
San Diego Aerospace Museum
San Diego, California

Editor's reply: Eisenhower soloed in a Consolidated PT-1. We were wrong—there is no such thing as a Stearman PT-1.

Tannenbaums Away

Your story on the Holly Run (December 1988/January 1989) brought back memories of a long time ago at NAS

Miramar before it became the home of the Navy's Top Guns.

Patrol Squadron One, the Flying P2V-2 Neptunes, received the discouraging news that its future home base was to be changed from Kaneohi Bay, Hawaii, to Whidbey Island, Washington, with forward rotation to the Aleutian Islands of Adak and Kodiak.

An advance group flew to Whidbey to look over facilities and make arrangements for housing. Those who had the duty that December 1947 afternoon waited for news of the "cold" north as Lieutenant V.H. Weaver taxied up to the operations office. Before he cut his engines, Vic opened the bomb bay and dropped a large bundle of Christmas trees on the tarmac. The general gloom that had hung over the squadron following the order change was lifted for a few minutes.

Whidbey Island had at least one advantage over Kaneohi Bay—every family's Christmas tree could be cut on base.

B.R. "Mike" Molony
San Bernardino, California

Remembering Carranza

The article "¡Viva Carranza!" in the October/November 1988 issue brought back some fine memories.

I grew up in Burlington County, New Jersey, during the 1930s and 1940s. Our family would go for a drive through the Pine Barrens several times a year, always stopping at the Carranza Memorial. It always made me sad because the memorial was all alone out in the boondocks. It was seldom that we saw anyone in the area.

It gave me a nice feeling to find out that the American Legion holds periodic memorial services there.

Leonard Shields
Cayuta, New York

No Mere Enthusiast

I'd like to make a few comments on "Taking Liberty" (Soundings, December 1988/January 1989) concerning my efforts to locate and recover *Liberty Bell 7.* First, I do not consider myself a "Mercury program enthusiast" because I feel that this term detracts from the very extensive and careful research that has been conducted over the past three years on the Mercury Redstone-4 mission and capsule no. 11. During that period, I kept trying to find some expert who could tell me what I needed to know about the flight until I realized that no such person existed. As a result, I have spent many long hours studying the records of Grissom's flight with "questionable enthusiasm" at times. But it had to be done and has given me a greater respect for what was accomplished in Project Mercury.

The figure quoted for recovering *Liberty Bell 7* is vastly in error. It could take anywhere from $750,000 to $1 million to raise the capsule. I haven't done an exact cost estimate because it is highly dependent upon the actual salvage technique, and this depends on whether a manned or unmanned vehicle is used. The final selection of a recovery vehicle will be somewhat governed by availability. There's not much of this hardware in existence and we have to catch the contractors when they aren't on the other side of the world. Currently, I am focusing on locating the precise position of the capsule and determining its actual condition.

The search for *Liberty Bell 7* will easily be the most demanding such operation in history, and though we have a pretty good idea as to the present location of the spacecraft, finding something that small in 15,500 feet of water is not going to be easy. But we don't know what can be done until we try.

Curt Newport
Arlington, Virginia

War of the Words

In the October/November 1988 issue, Jim Koontz of the Tradewind Aerialists Skydiving Exhibition Team corrected the word *parachutist* to read *skydiver.* To me, however, the proper term is *sport parachutist.*

Whatever you call it, parachuting has progressed to the point where millions of viewers thrilled to the opening ceremonies of the South Korea Olympics. Here's wishing that the future holds many more such spectacles for us.

Robert Clupper
Mentone, Indiana

Paul F. Cappellano's statement that he has "not a single instance" of *venerian* to describe matters "of or relating to the planet Venus" is puzzling (Letters, December 1988/January 1989).

Venerian in this precise sense (referring to climate, life forms, and language) has been in common and widespread usage in science fiction circles since at least 1948, when it figured prominently in Robert A. Heinlein's novel *Space Cadet.*

Either Cappellano and his colleagues at Merriam-Webster haven't been doing their homework, or, I fear, they've fallen victim to a certain degree of intellectual snobbery in deciding what constitutes legitimate usage.

Fred Erisman
Lorraine Sherley Professor of Literature
Texas Christian University
Fort Worth, Texas

In the opening of his letter in the December 1988/January 1989 issue, Raymond W. Doreian leaves much to be explained. He writes, "As a survivor of two aircraft crashes . . . " He was correct in saying he *missed* two flights. He was not a survivor.

J.R. Wells
Alexandria, Virginia

Mark Your Calendar

My December 1988/January 1989 issue of *Air & Space/Smithsonian* arrived today, and I was surprised to note that the December 17, 1903 date was overlooked in the Calendar section.

I realize that every milestone in air and space history cannot be listed in each issue. However, the date of man's first flight, as well as the date of man's first landing on the moon, should, like Christmas, be noted on every calendar.

Tom Wagner
Metairie, Louisiana

Air & Space/Smithsonian *welcomes comments from readers. Letters must be signed and may be edited for publication. Address letters to* Air & Space/ Smithsonian, *National Air and Space Museum, Smithsonian Institution, Washington, DC 20560.*

IMAGINE ONE JET WITH THE FIREPOWER OF A WWII SQUADRON.

Today's fighting jets are so packed full of the latest technology they seem to belong in the future: F-14s that can track 24 targets at once and attack six of them with a deadly mix of Sparrow, Sidewinder, and Phoenix missiles…Harrier jump jets able to take off straight up and fly backwards…Soviet Foxbats that can fly at an astounding 2100 mph…

Now there's one source you can turn to for all but the most classified information on these high-tech wonders of the sky. The editors of TIME-LIFE BOOKS present *Fighting Jets,* an exciting volume in which you'll find out the latest advancements in the ever-changing battle for air supremacy.

And you'll not only learn about the incredible capabilities of the top fighters in the world—such as the near-invincible F-14 and the mysterious Soviet MiG-25. You'll also enter the cockpit in actual combat situations to see how these jets respond when it really counts.

It's just the beginning of the adventures you'll take in THE EPIC OF FLIGHT series from TIME-LIFE BOOKS. You'll learn how the planes of today were made possible by exploring earlier generations of attack aircraft in such exciting volumes as *America in the Air War, Knights of the Air,* and *The Carrier War.*

Simply mail the attached card or coupon. You'll receive *Fighting Jets* for a 10-day free examination. Keep it and pay just $3.99—a saving of $10—plus shipping and handling. Or send it back with no obligation. Future volumes at only $13.99 (plus shipping and handling) come one about every other month, each with the same 10-day free trial. Keep only the books you want. Cancel any time.

But send in the reply card today. The sooner you do, the sooner you'll be climbing into the cockpits of the most sophisticated fighters in the sky.

TEST FLY FIGHTING JETS FOR ONLY $3.99.

If card is missing, mail to: Time-Life Books, Box C-32066, Richmond, VA 23261-2066.

Yes, I would like to try *Fighting Jets* as my introduction to THE EPIC OF FLIGHT series. Please send it to me for a 10-day free examination at only $3.99 (a $10 saving). Also send me future volumes under the terms described in this ad. CVGB36

Name_____ (please print)

Address_____ Apt._____

City_____

State/Province_____ Zip/Postal Code_____

All orders subject to approval. Price subject to change.

THE EPIC OF FLIGHT TIME LIFE BOOKS

NASA's Roots

GREG HARLIN/SRW INC.

It was the first chilly day of fall in the flatlands near California's Silicon Valley. At Ames Research Center's Moffett Field, a steady breeze rustled the paper tablecloths on the picnic tables near the runway. Some 200 guests attending the fourth reunion of the National Advisory Committee for Aeronautics lined up to collect their box lunches and watch a small parade of NASA aircraft.

A white Lockheed U-2 taxied to the runway and rose like a rocket. The picnickers put down their sandwiches and applauded. Then NASA's Quiet Short-Haul Research Aircraft silently corkscrewed into the sky. The guests gave it another round of applause.

The NACA ("That's 'en-ay-cee-ay,' never 'nacka,' " says former Ames director Clarence Syvertson) reunions are held every few years, usually near NASA facilities, and comprise three days of buffets, banquets, and brunches. Attendance is limited to people who worked for NACA before it was absorbed by the newly formed NASA on October 1, 1958, precisely 30 years before last year's picnic. "It's kind of like a last-man club," says John Dusterberry.

Dusterberry, an electrical engineer who helped design Ames' mammoth 40- by 80-foot wind tunnel in 1943, recalls the atmosphere at NACA before the transition. "We lived a nice, quiet, simple life, with a small budget and without publicity. We did the research we wanted to do and we had the money to do those things that were really important. And we were never criticized for doing things wrong because nobody saw it."

All that changed when the Soviets launched Sputnik on October 4, 1957. With the National Aeronautics and Space Act, President Eisenhower proposed a civilian agency that would coordinate space exploration and military research with NACA's aeronautical research. The National Aeronautics and Space Administration began operation with a $331 million budget, and NACA, established in 1915 with a $5,000 budget, virtually disappeared.

"[NACA] was a world-famous institution," says Charles Donlan, who signed on in 1938 and remained through the NASA transition. "It was on the frontier of every aeronautical advance for 30 years."

Despite the huge increase in budget and staff, some things stayed the same. "It was the professional camaraderie, common interest, and respect for one another that survived," Donlan says. "That really didn't change when it became NASA. And that's why we still get together."

The U-2 made another flyby and then settled into its landing approach. It was announced that this was probably the last public demonstration of this particular airplane, which was 30 years old and due to retire. The picnickers rose and gave it an ovation.

—Elaine de Man

Aaaand—They're Off!

What can a flight attendant do when a passenger balks at boarding an airplane? "My men change his mind," Tex Sutton says. "They just lock their arms behind him and push him right on up."

No, it's not a new get-tough program for fearful fliers. Sutton's business is shipping Thoroughbred racehorses by air, and his

The Martian Chronicles

KEN KERBS (4)

The pencil poised over the map of New Jersey could have landed anywhere: Cheesequake, Ho-Ho-Kus, Double Trouble, or Brass Castle. But in the hand of a radio scriptwriter who was selecting the site of a Martian invasion with his eyes closed, it fell on a hamlet near Princeton in the township of West Windsor. Grover's Mill's place in history was merely a broadcast away.

Fifty years after Orson Welles' Mercury Theater panicked millions of radio listeners with its "War of the Worlds" broadcast, Grover's Mill celebrated the anniversary of the space

invasion that never happened.

The supposed 1938 Martian landing site is actually Van Nest Park, and last October a bronze commemorative marker, featuring Welles at the microphone, a spaceship, and a family cowering by their radio, was unveiled and blessed by a clergyman. New Jersey governor Thomas Kean boosted the state, and actors from the new "War of the Worlds" TV series posed for pictures. Also on hand was Howard Koch, writer of the radio adaptation of the H.G. Wells novel and wielder of the notorious pencil. (Some proceeds of the four-day celebration will fund a Howard Koch scholarship for students of broadcasting, journalism, and space exploration.)

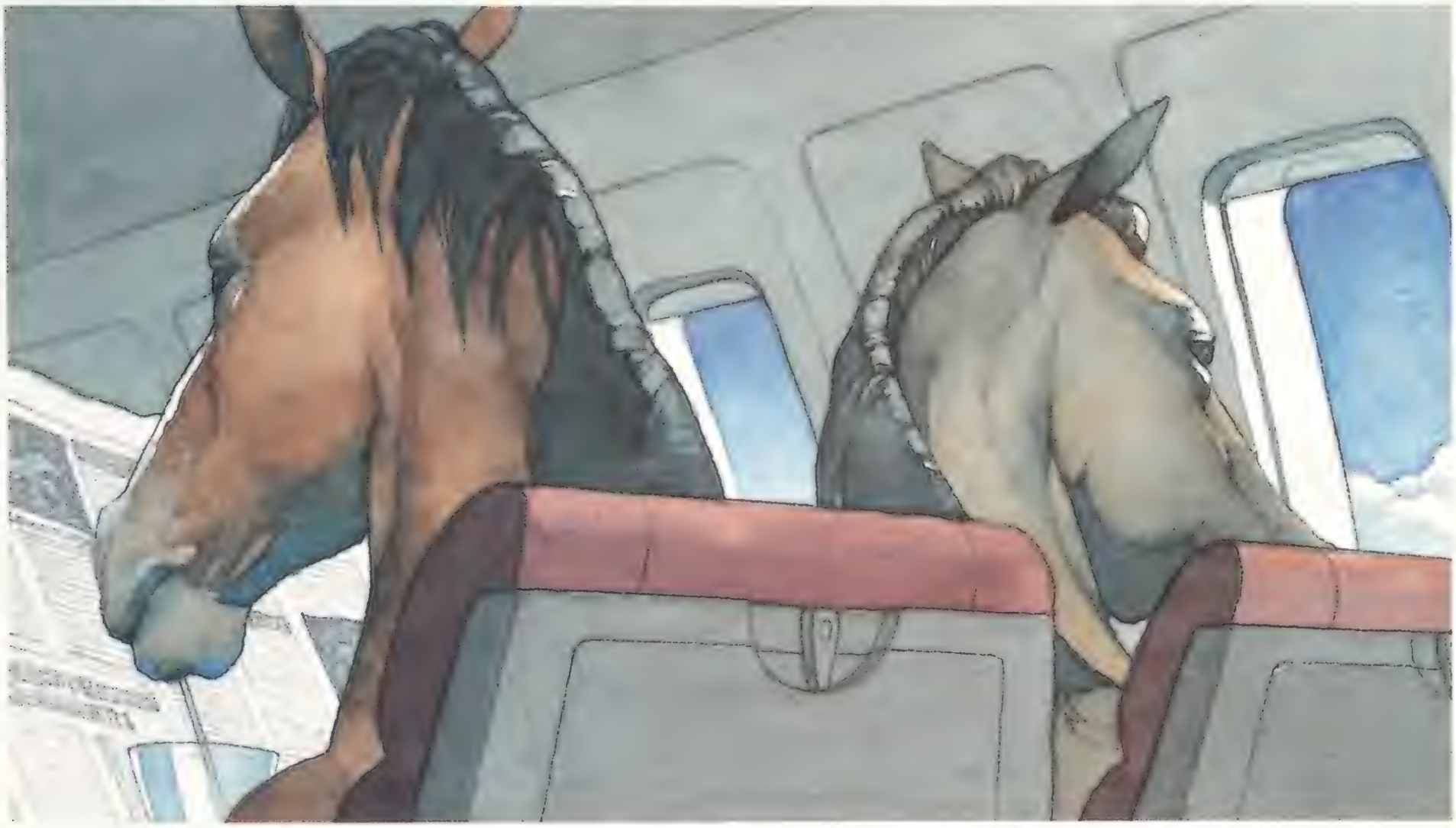
"How exactly do you celebrate a panic?" asked guest Garrison Keillor. But the town had plenty of ideas: Martian Panic bike races and a 10-kilometer run, a Martian Landing parade, art show, dinner dance, and masquerade ball, for starters.

There were also carnival rides, laser shows, and fireworks. And folks donned metallic jumpsuits and green face paint and placed foil-covered spaceships on Grover's Mill lawns.

Two panel discussions—"Could It Happen Again?" and "Should We Go to Mars?"—and a performance of the original script in a Princeton theater wrapped up festivities, but not before Keillor pointed out the rare form of justice dispensed when a small town, victimized by the media, can 50 years later come back to exploit that same media so successfully. But it was Koch who had the last laugh. In December his original script, which Sotheby's figured would bring $30,000, fetched $143,000.

—Wes Eichenwald

GREG HARLIN/SRW INC.



1,200-pound passengers take flying in stride—mainly because they never realize they're airborne. Unable to see outside, they stand in padded steel stalls, munch hay, and generally relax. "The purr of the motors just puts them to sleep," says Sylvester Veitch, a trainer with 54 years in the business. The flights *are* among the smoothest rides the animals experience. "The horse runs into more roughness by going from the racetrack to the airport," Sutton says.

Such luxurious travel is simply sound management for racehorse owners. "If you've got a horse that's capable of making a lot of money, you have to go where the money is," Sutton points out. Air travel allows a promising horse to participate in a wider variety of high-stakes races, and helps ensure that the animal will arrive at the track in better shape than if it had been trailered. Sutton's passengers, therefore, tend to be among the more successful racers, including equine superstars Alysheba and John Henry. However, they also include the occasional mare being shipped for a breeding date or a yearling en route to a new home.

Sutton estimates that 98 percent of those who ship Thoroughbred racers by air use his H. E. Sutton Forwarding Company, which started shipping horses by rail in 1953. When Sutton's rail costs jumped 300 percent in 1969, "I said I'd finish the run and then I quit," he says. "Went to California, had some stalls made, and went into [the air] business right then."

Sutton first used a Lockheed 188 Electra, which (no doubt unintentionally) was designed with some of the features of a good horse trailer. "When you loaded the plane, you loaded it from the back door forward. Then when you off-loaded it, you walked them right on out from the front door," he says. "It was a good, safe airplane for horses. It had a high ceiling in it, and the horse had plenty of head room."

Now based in prime racehorse country—Lexington, Kentucky—Sutton charters a Boeing 727 from Connie Kalitta Services in Ypsilanti, Michigan. Kalitta delivers the 727 to Sutton's shipping site, where a crew of 12 spends about an hour outfitting it with 18 stalls and a ramp.

A stall on a New York-to-California flight runs about $2,850. Business is booming—in a typical month Sutton has a shipment nearly every day. Last November, for example, he shipped horses on all but the few days he took off around Thanksgiving.

The former Texan (if there is such a thing), now age 67, has been around racehorses since age 11. "I've been all over the country on the racetrack—as a groom, exercise and pony boy, valet, farm manager . . . ," he says. "All of them I like. This is the most profitable."

—Karen Jensen

Orbital Mechanics

Last October, while the rest of us put up storm windows and raked leaves, Vladimir Titov and Musa Manarov did a fall clean-up on the Mir space station.

The cosmonauts accomplished several tests and tasks during a four-hour spacewalk. They took new spacesuits for a test-drive and completed repairs on an external telescope on the Kvant astrophysical module. They also assembled an amateur-radio antenna, mounted a new anchor that a recent Soviet-French mission used to test solar panels, and dusted off portholes and a camera lens.

The schedule was based on the replacement of a block of electronic detectors in the Dutch telescope. The cosmonauts had started the job during a previous spacewalk but left it incomplete when they broke the key to the detectors' fastening ring. The mission "developed into quite a problem," says repair specialist Oleg Tsygankov. "We had to devise three methods of separating or breaking up the ring embedded in the telescope's tube." A special tool kit was assembled for the task. Because the majority of the ring removal was done on the first repair attempt, Tsygankov figured that the crew, using their custom-made tools, would need only 10 minutes to finish the job. They could then spend the rest of the spacewalk

Hughes Aircraft Company was the recipient of the U.S. Army Award for outstanding achievements in Value Engineering for cost-savings. In 1987, Hughes Value Engineering Change Proposals (VECPs) saved customers over 53 million dollars. Since 1964, 735 Hughes VECPs on 53 programs have resulted in a total savings of 1.136 billion dollars. Some of the programs benefitting from the VECPs include F/A-18 avionics, Maverick, Phoenix, and Advanced Medium Range Air-to-Air Missiles, M1 Abrams Tank, Bradley Fighting Vehicle, and the AN/UYQ-21.

Revolutionary computer architectures have the potential to achieve massive parallel processing capabilities beyond that of the fastest conventional supercomputers. Under development by Hughes for the U.S. Army Strategic Defense Command, these new architectures are designed to mimic the brain's vastly complex neurobiological structure. Using this technology, a new generation of computers may provide the solution for real-time processing problems like automatic target recognition, weapons allocation, automatic speaker identification and multi-sensor data fusion.

A liquid crystal light valve makes possible high-resolution display of full color, real-time computer graphics. The light valve, part of a new superprojector developed at Hughes, acts as an image intensifier which modulates light from high-intensity xenon arc lamps with the image from a low-intensity ultra-high resolution CRT. The red, green, and blue information is converged digitally on the projection screen. The resulting image has a resolution in excess of 1,000 TV lines. Image flicker is eliminated by the inherent properties of the light valve, and electronic raster shaping corrects for keystone effect. Applications for the projector, designated Model 1000, include air traffic control centers, status board presentations, technical presentations, trade shows and exhibits.

A pioneering project for the long distance transport of unprocessed gas will drive the gas through a pipeline for injection into a reservoir 30 miles away. Norsk Hydro's Troll-Oseberg Gas Injection (TOGI) project, in the Norwegian North Sea, is utilizing two-phase gas/liquid pipeline flow, diverless installation and maintenance, and remote control of the module from the Oseberg A platform over a greater distance than ever attempted before. Hughes is providing subsea electronics for the sophisticated controls system, as well as multiplexed electro-hydraulic controls using major electronics and control pod techniques developed in conjunction with Vetco Gray. The project is scheduled for completion in late 1989.

Hughes Missile Systems Group is advancing every phase of research and development, as it applies to tactical guided missile systems and strategic defense. Opportunities for engineers and scientists are in analog/digital circuit design; high-voltage power supply design; electro-optical design; IR imaging sensors; focal plane arrays; and systems engineering. Send resume to Hughes Engineering Employment, Dept. S4, 8433 Fallbrook Ave., Canoga Park, CA 91304. Equal opportunity employer. U.S. citizenship may be required.

For more information write to: P.O. Box 45068, Los Angeles, CA 90045-0068

HUGHES

Subsidiary of GM Hughes Electronics

THE POWER OF ORIGINAL THINKING.

mounting the anchor, assembling the antenna, and dusting.

Prior to the spacewalk, Titov and Manarov donned the improved spacesuits and worked on copies of the telescope's fastening ring inside the space station. Adjustable sleeves and more flexible gloves allowed greater dexterity, and an extended life support system increased the maximum spacewalk time to six hours.

Early on the morning of October 20 Titov and Manarov began preparing for the day's tasks. At 10 a.m. they opened the outer hatch and emerged from the station. A tangled tether was the first of several minor difficulties, but somehow the cosmonauts coped with each problem as it arose. They completed their agenda by 2 p.m., about an hour ahead of schedule. And eight weeks later, by mission's end, Titov and Manarov had set a new space endurance record of a full year in orbit.

—Mikhail Chernyshov, Novosti Press Agency

Insider Trading

"We had about 300 people turn out for our first show two years ago," says Bryant Petitt, surveying tables laden with model airliners, old flight schedules, life vests, vintage china, pilot wings, airline uniforms, and airsickness bags. "Now we get twice that many."

Business was brisk at Airliner Expo Atlanta '88, held last October at the Sheraton Atlanta Airport Hotel. Petitt, an airline ticket agent and member of the World Airline Historical Society, had billed the event as "North America's largest one-day airliner show." It drew more than 70 dealers of airline memorabilia from across the country, half of whom were current or retired airline employees.

"I started collecting little odds and ends in 1955," says Augie Goetz of St. Louis, who worked for TWA for 40 years, "and the whole thing pyramided from there." Today Goetz deals exclusively in TWA items. And though he came to Atlanta to sell, like the other dealers he ended up buying as well, paying $90 for a 1950s silver serving dish. "I paid more than it's worth," he admits, "but this is something I've been after for a long time."

Breaking even is the goal of these hobbyists. John Joiner, an airline mechanic and the show's co-organizer, took in $500 but spent almost that much for Southern Airways and Pan American Air Ferries insignia.

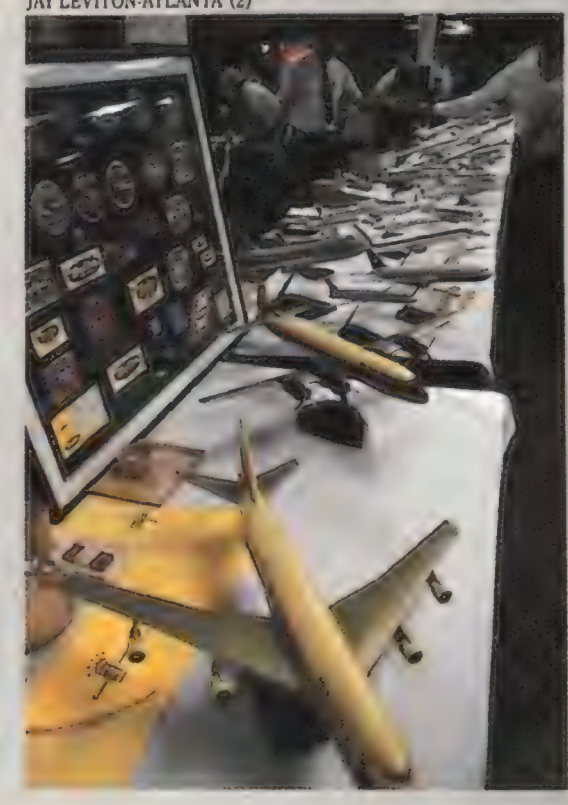
Among the pricier items were a travel agent's $400 KLM Constellation display model and $250 "fat airplane" caricatures by Delta baggage handler Alex Black. But there were plenty of trinkets in the under-$5 range, and some dealers were willing to barter. Linda Dickerson, a sales manager for a car rental firm who flies single-engine Pipers for fun, traded a framed print of the Bell X-1 for "all the old airline china I could get in my car."

Charles Quarles, a North Carolina dentist, was scouting around for wings worn by airline crews. He already has some 4,000 on display in his basement, along with 25 mannequins dressed in airline uniforms.

"I remember going with my parents to the airport in Charleston, West Virginia, where you could stand by the fence and look at the planes," says Quarles. "This memorabilia reminds you of a time when air travel was glamorous and exciting, before it became just another form of mass transportation."

—Sharron Hannon

JAY LEVITON-ATLANTA (2)



Robots in the Hangar

In the past, mechanics at McClellan Air Force Base in Sacramento, California, had to perform the equivalent of exploratory surgery on aircraft to expose potential problems. Skins, wings, and tails would be removed in a time-consuming inspection of the ravages of time, G-forces, and weather. Now they get the equivalent of a CAT scan in a process that could reshape aircraft maintenance techniques.

Last November the world's largest "gantry robotic scanning system" was installed at the Air Force maintenance outpost. So effective are the two robots—ceiling-suspended machines with huge claw-like arms—that an F-111 inspection that once took more than a month can be completed in 36 hours.

The mammoth X-ray robot replaces smaller units that required aircraft disassembly to search for cracks in metal. The second behemoth, an "N-ray" robot, was adapted from a medical technology in which image-intensified neutron radiography is used to scan blood flow in humans. In aircraft, the machine pinpoints areas of corrosion—what mechanics call cancer—as small as 2/1,000 of an inch by detecting hydrogen, a corrosion by-product. It can also find even smaller cracks and erosion in composite materials.

"The Advanced Tactical Fighter and other aircraft coming on stream are going to have more composite materials," says maintenance director Ken Eickmann. "You can't find small cracks in composites with X-ray. You can with neutron radiography."

The two robots produce real-time imagery, a giant leap over systems that require film processing and review. Their track record has drawn the attention of the rest of the aviation community. "The Navy is very interested because of corrosion problems with aircraft on ships," says Eickmann. "The Navy could fly F-14s and F-18s up here, put them in our facilities, and let us do a scan. In a day or two, the pilot can fly home with his videotape and the Navy depot can do any repairs." If funding allows, the Air Force will install similar systems at other bases.

Robert Lutzinger, an inspection manager at United Airlines, says his company, which uses X-ray equipment, is quite impressed with McClellan's robots. "In the old days you could check for moisture in a flight control by tapping it with a quarter," Lutzinger says. (Moisture-containing areas sound less solid than dry areas.) "But in dealing with aircraft that fly higher, faster, and farther than ever before, the airline industry is going to have to adopt these new disciplines."

—Douglas Baldwin

AIRBUS INDUSTRIE

"Grasp tail firmly; shake over medium heat until all kernels have popped and aluminum is fully expanded."

MIKE BEST/USAF

Planning a Saturn Sojourn

"With our choice we are trying to put pressure on NASA to make their own choice," admits Roger Bonnet, scientific program director at the European Space Agency. "In other words, we've tried to be the leader" in promoting a joint planetary probe.

Last November, after several years of weighing the pros and cons of five deep-space missions, ESA selected a proposed U.S.-European Cassini mission to Saturn and its intriguing moon Titan as the agency's next major space science project. The 13-nation consortium ventured out along the same limb that cracked when a 1981 budget cut reduced NASA participation in a joint solar polar mission and left ESA to its own devices. The result was Ulysses, a European craft that will be launched from the U.S. shuttle in 1990 and examine the poles of the sun. If another

The ultimate in sound... The ultimate in savings...

GET 6 COMPACT DISCS FOR THE PRICE OF ONE

...with nothing more to buy ever!

And...take advantage of our INSTANT HALF-PRICE Bonus Plan!

SAVE 50% Unlike other clubs, you get 50%-off Bonus Savings with every CD you buy at regular Club prices, effective with *your first* full-price purchase!

200583. John Lennon: Imagine/Soundtrack. Jealous Guy, Mother, more. (Capitol)

174328. George Harrison—Cloud Nine. Got My Mind Set On You, more. (Dark Horse)

134347. Huey Lewis: Small World. Latest good time rockers include Perfect World, more. (Chrysalis)

115356. Vivaldi, The 4 Seasons—Trevor Pinnock. (Archiv *DIGITAL*)

180187. Bruce Hornsby & The Range: Scenes From The Southside. The Valley Road, more. (RCA)

100008. Randy Travis: Old 8x10. Honky Tonk Moon, Deeper Than The Holler, more. (Warner-Bros.)

125179. Tchaikovsky, 1812 Overture; Nutcracker Suite; more—Solti. (London *DIGITAL*)

163629. Whitesnake. Still Of The Night, Give Me All Your Love, more. (Geffen)

100517

200596. U2: Rattle & Hum. Live set includes I Still Haven't Found What I'm Looking For, Desire, more. (Island)

182522. Dirty Dancing/ Original Soundtrack. (I've Had) The Time Of My Life, more. (RCA)

200478. Metallica: And Justice For All. One, Blackened, title song, more. (Elektra)

100603. Kenny G: Silhouette. We've Saved The Best For Last, more. (Arista)

154404. Chicago 19. Don't Wanna Live Without Your Love, Heart In Pieces, etc. (Reprise)

115457. Itzhak Perlman: French Violin Showpieces: Carmen-Fantasy, Havanaise, more. (DG *DIGITAL*)

144578. The Judds: Greatest Hits. Give A Little Love, Mama He's Crazy, etc. RCA

223559. Beach Boys: Endless Summer. 20 Greatest Hits.

115306. Handel, Water Music—Trevor Pinnock. (Archiv *DIGITAL*)

100601. Squeeze: Classics. Take Me I'm Yours, Striking Matches, Tough Love, more. (A&M)

104898. Cream: Disraeli Gears. Sunshine Of Your Love, more. (Polydor)

173233. James Galway: Greatest Hits. (RCA)

154633. Steve Winwood: Roll With It. Don't You Know What The Night Can Do?, Holding On, etc. (Virgin)

100470. Vangelis: Direct. (Arista)

153582. Tracy Chapman: Fast Car, Talkin' Bout A Revolution, Baby Can I Hold You, etc. (Elektra)

115436

152854. Whitney Houston: Whitney. Didn't We Almost Have It All, etc. (Arista)

150913. Van Halen: OU812. (Warner Bros.)

134073. Richard Marx—Hold On To The Nights, Endless Summer Nights, Should've Known Better, etc. (EMI)

163579. Segovia Plays Ponce, Rodrigo & Torroba (MCA)

100579. K.T. Oslin: This Woman. Money, title song, Hey Bobby, etc. (RCA)

100035. Robert Palmer: Heavy Nova. Simply Irresistible, etc. (EMI-Manhattan)

120768. 20 Greatest Love Songs Of The 50s & 60s. (Laurie)

123721. Jimmy Page: Outrider. (Geffen)

134321. Led Zeppelin. Houses Of The Holy—The Song Remains The Same, more. (Atlantic)

105392. Pops In Space—Boston Pops/Williams: Star Wars, Superman, more. (Philips *DIGITAL*)

173406. Jazz CD Sampler. 15 performances from Louis Armstrong, others! (PolyGram)

123790. James Taylor's Greatest Hits. Fire And Rain, Sweet Baby James, more. (Warner Bros.)

154537. Carly Simon: Greatest Hits Live Anticipation, You're So Vain, more. (Arista)

115541. Bach, Brandenburg Concertos 1-3—Pinnock. (Archiv *DIGITAL*)

172190. Elvis Presley: 18 No. 1 Hits (RCA)

134267. Mozart, Overtures. Marriner. (Angel *DIGITAL*)

100591. Steve Miller: Born To Be Blue. Ya, Ya, more. (Capitol)

273965. Sting: Nothing Like The Sun. We'll Be Together, more. (A&M)

134647. J. R. Baker: Rhapsody In Electric Blue. Gershwin on synthesizer! (Newport Classic *DIGITAL*)

244006. Simon & Garfunkel: The Concert In Central Park. [1 disc] (Warner Bros.)

124705. Jethro Tull: Aqualung. (Chrysalis)

134408. David Sanborn: Close-Up. Slam, You Are Everything, Way, etc. (Warner Bros.)

153606. INXS: Kick. Need You Tonight, New Sensation, etc. DIGITAL (Atlantic)

153621. Beethoven, Symphony No. 7; more. Royal Phil. Previn. (RCA *DIGITAL*)

164165. Bobby McFerrin: Simple Pleasures. Don't Worry Be Happy, All I Want, etc. (EMI)

125264. Horowitz in Moscow—Scarlatti, Mozart, Rachmaninov, others. (DG *DIGITAL*)

144313. Classic Rock: Vol. 1. Elton John: Bennie & The Jets, more. (MCA)

170348. Guns 'N' Roses: Appetite For Destruction. Welcome To The Jungle, It's So Easy, etc. (Geffen)

163322. Elton John: Greatest Hits, Vol. 1. Your Song, Daniel, others. (MCA)

160027. Alabama: "Live". Love In The First Degree, There's No Way, Dixieland Delight, etc. (RCA)

100516

130230. Crosby, Stills, Nash & Young: So Far (Greatest Hits). Suite: Judy Blue Eyes, more. (Atlantic)

124546. The Moody Blues: Sur La Mer. I Know You're Out There Somewhere, No Lies, etc. (Threshold)

143293. Glenn Miller Orchestra: In The Digital Mood. (GRP)

114780. Cinderella: Long Cold Winter. Gypsy Road, Don't Know What You Got (Till It's Gone), etc. (Mercury)

154358. Slatkin Conducts Pictures At An Exhibition, more—(RCA *DIGITAL*)

144659. The Best Of The Spencer Davis Group. Steve Winwood & Co. on Gimme Some Lovin, etc. (EMI)

100352. Diane Schuur: Talkin' 'Bout You. Title song, Funny (But I Still Love You), etc. (GRP)

104857. Benny Goodman: Sing, Sing, Sing. Title song, more. (RCA)

START NOW WITH 4 COMPACT DISCS!

Yes, pick any 4 compact discs shown here! You need buy just one selection at regular Club prices (usually $14.98–$15.98)...and take up to one full year to do it. Then you can choose another CD free as a bonus. That's 6 compact discs for the price of 1 and there's nothing more to buy...ever! (Shipping & handling added to each shipment.)

HOW THE CLUB OPERATES

You select from hundreds of exciting compact discs described in the Club's magazine and mailed to you approximately every 3 weeks (19 times a year). Each issue highlights a Featured Selection in your preferred music category, plus alternate selections. If you'd like the Featured Selection, do nothing. It will be sent to you automatically. If you'd prefer an alternate selection, or none at all, just return the card enclosed with each issue of your magazine by the date specified on the card. You will have at least 10 days to decide, or you may return your Featured Selection at our expense. Cancel your membership at any time after completing your membership agreement, simply by writing to us.

FREE 10-DAY TRIAL

Listen to your 4 introductory selections for a full 10 days. If not satisfied, return them with no further obligation. You send no money now, so complete the coupon and mail it today.

BMG Compact Disc Club
6550 E. 30th St., Indianapolis, IN 46219-1194.

CD688 COMPACT disc DIGITAL AUDIO

BMG COMPACT DISC CLUB

YOUR SAVINGS START HERE

Mail to: BMG Compact Disc Club
P.O. Box 91412/Indianapolis, IN 46219

YES, please accept my membership in the BMG Compact Disc Club and send me the four Compact Discs I've indicated here, billing me for just shipping and handling under the terms of this ad. I need buy just 1 CD at regular Club prices during the next year—after which I can choose a FREE bonus CD! That's 6 for the price of 1...with nothing more to buy ever! (Shipping & handling is added to each shipment.)

RUSH ME THESE 4 CDs (Indicate by number):

D	D	D	D

I am most interested in the musical category checked here—but I may always feel free to choose from any (check one only):
1 ☐ **EASY LISTENING** (Instrumental/Vocal Moods)
2 ☐ **COUNTRY** 3 ☐ **HARD ROCK**
4 ☐ **POP/SOFT ROCK** 5 ☐ **CLASSICAL**

☐ MR.
☐ MRS. _____
☐ MISS First Name Initial Last Name (PLEASE PRINT)

Address _____ Apt. _____

City _____ State _____ Zip _____

Telephone (Area Code) _____

Signature _____

YBT59 (BU)

Limited to new members, continental USA only. Current CD Club members not eligible for this offer. One membership per family. We reserve the right to request additional information or reject any application. Local taxes, if any, will be added.

budget cutback forces NASA to cancel Cassini plans, ESA will reopen the mission competition and select one of the remaining four ventures, which include joint missions with the Soviet Union, Australia, and Canada.

The selection announcement put the ball in NASA's court—specifically, in the middle of the budget allotment scramble, the emphasis on manned missions and space station funding, and the backlog of scientific missions caused by the *Challenger* explosion. If Congress approves NASA's 1990 budget, the agency will combine the Saturn orbiter project with a Comet Rendezvous Asteroid Flyby mission for a total of $800 million. ESA estimates that its Titan probe Huygens, named after Titan's discoverer, will cost $288 million.

Cassini, named for the astronomer who in 1675 detected a gap in Saturn's rings, will be launched in 1996 and reach Saturn in 2002. While studying the planet, its rings, and its satellites during a four-year orbit, Cassini will release Huygens, which will sample Titan's nitrogen-rich atmosphere, relay its findings to Earth, and attempt a landing on the moon, which is believed to be covered with a frozen sea of liquid ethane and absorbed methane gas. Titan's atmosphere, with its complex organic chemistry, may contain clues to the evolution of life on Earth.

In 1986 ESA scored an enormous success with the Giotto probe, which rendezvoused with Halley's Comet. The agency views the Cassini mission as a giant step in "introducing planetary exploration as a major theme in Europe's long-term space science program," says Bonnet.

—Judy Yablonky

Update

Alec Galeev has replaced Roald Sagdeev as director of the Soviet Union's IKI Space Research Institute ("The Space Statesman," October/November 1988). Sagdeev resigned last year, in part to return to basic research. An IKI scientist praised Galeev for his extensive experience, reputation among U.S. and European peers, and interest in international cooperation.

The success of the Kuiper Airborne Observatory has encouraged NASA to plan an upscale version (Above & Beyond, October/November 1988). A Boeing 747 carrying a telescope with 10 times the light-gathering power of the KAO's could be operating by the mid-1990s as a joint venture between the U.S. and West Germany.

Airliners at Denver's Stapleton Airport will be checked this winter for icing by a runway crew just prior to takeoff (Groundling's Notebook, August/September 1988). The new inspections were ordered after the Department of Transportation blamed a November 1987 crash on the crew's failure to de-ice a second time during a takeoff delay.

Wind Tunnels: Not just for airplanes anymore! Now jockeys are eligible for streamlining, thanks to wind tunnel research by Richard Brandt of New York University ("Into The Wind," February/March 1988). The physics professor discovered that a jockey wearing form-fitting silks in a one-mile race has an advantage of nearly nine feet over a competitor who is wearing traditional silks.

By 1990, F-16 and F-15 aircrews will be wearing anti-G vests with their standard G-suits ("High Gs, High Risk," October/November 1987). Part of a new Tactical Life Support system that will also provide protection from chemical warfare and lasers, the positive-pressure breathing device, called Combat Edge, will enhance G-load tolerance by putting pressure on the abdomen and increasing oxygen flow to assist breathing.

The Solar Max satellite, which has been studying the sun for nine years, has been written off by NASA, much to the dismay of the scientific community ("Here's Looking at You, Sol," October/November 1986). Due to a standing-room-only shuttle manifest and a budget crunch, the agency has announced that it cannot afford to retrieve or repair the satellite or boost it into a higher orbit. It is expected to reenter the atmosphere and disintegrate in 1990.

Doppler radar to detect wind shear will be installed at 47 U.S. airports beginning in 1992 ("The Might of the Microburst," August/September 1986). Last November, Transportation Secretary James H. Burnley said the system could contribute more to air travel safety than "any other individual item of equipment" in the plan to upgrade U.S. air traffic control.

—Patricia Trenner

Anniversaries . . .

GREG MORT

In 1655 astronomer Christiaan Huygens made a titanic discovery.

1655
March 25 Dutch astronomer Christiaan Huygens discovers Titan, the largest of Saturn's moons.

1923
March 13 The U.S. departments of war and agriculture decide to use Army airplanes to spray calcium arsenate on the boll weevil-ravaged cotton fields of Louisiana.

1925
February 16 Herbert Olmstead, a New Jersey state trooper who lost his hearing after a head injury, ascends from an Army air station at Mitchel Field, Long Island, in an effort to cure his deafness. At the suggestion of Army medical officers, the trooper was flown to 12,000 feet and subjected to a series of dives, spins, side slips, and loops. After landing, Olmstead reported that he could hear human voices for the first time in three years.

Eight days later, a swift drop of 5,700 feet in an airplane restored almost complete hearing to Samuel Brndgar of West Palm Beach, Florida, who had been deaf for six years. According to Brndgar's doctor, the rapid pressure changes jarred his rigid ear bones loose, permitting them to vibrate.

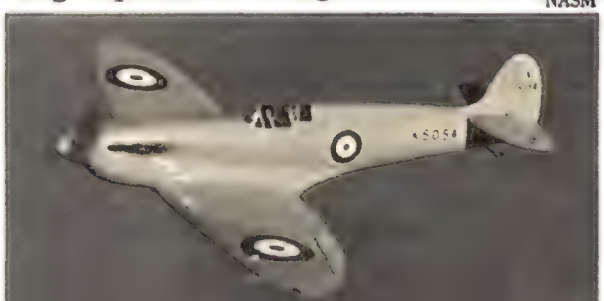
1926
March 14 An Oriole airplane belonging to the Curtiss Aeroplane Company is flown under the Brooklyn and Manhattan bridges. When the Oriole landed, surprised Curtiss employees discovered that Viola Gentry, a restaurant worker not licensed as a pilot, was at the helm with a Curtiss employee riding as a passenger. New York's Department of Plant and Structures said that a permit for a woman to fly beneath the bridges had been requested, but that none was required.

March 23 Twelve Army Air Service reserve officers in San Antonio, Texas, request that reserve pilots periodically take Air Service wives along for airplane rides (without compensation). The request stated that "such action will stimulate the enthusiasm of the Air Service Reserve and will reduce the objection now so prevalent on the part of their families to flying."

1936
March 5 Supermarine's Spitfire prototype fighter, K5054, takes off from Eastleigh Airfield in Southampton, England, on its first flight. Once airborne, the hand-built airplane was so easy to handle that test pilot Mutt Summers, not wanting the fighter altered, exclaimed, "Don't touch anything!" upon landing.

The thinness of the Spitfire's elliptical wing helped reduce drag.

NASM



March 9 Hermann Goertz, a German lawyer, is found guilty of violating Britain's Official Secrets Act by sketching the Royal Air Force station at Manston, England. Goertz had come to England seven months earlier, saying that he intended to study law at Cambridge. After he did not return to his bungalow on October 26, a residence search turned up a sketch of the Manston air station as well as a 1934 application to the intelligence branch of the German Air Ministry. During his trial, Goertz, who had worked as a German intelligence officer during World War I, claimed he had sketched the airfield for a romantic novel he was writing. The jury sentenced him to four years in prison.

NASM

Test pilot Hanna Reitsch was awarded the Iron Cross by Adolph Hitler in 1941.

1938

February 14 A helicopter is flown indoors for the first time. Inside Berlin's huge Deutschland Halle, German aviator Hanna Reitsch rose from the center of the arena in a Focke Achghelis Fa 61 and flew backward, forward, and sideways before a crowd of 20,000. During World War II she was a leading German test pilot, flying a specially designed V-1 missile and nearly dying in the crash of a rocket-propelled Me 163. Reitsch described flying the Me 163 as an "exhilarating experience. It was like thundering through the skies on a cannonball, and like being intoxicated by speed."

February 18–28 The Royal Italian Aero Club holds the Sahara Rally, a grueling 2,130-mile race from Gadame to Tripoli in North Africa. Of 23 participants, only 13 fliers completed the course.

1968

February 21–22 In a study of upper atmospheric winds, NASA launches six Nike-Apache sounding rockets from Wallops Island, Virginia. One rocket unleashed a reddish orange sodium cloud visible for hundreds of miles along the East Coast; the other rockets ejected compounds that generated much fainter blue and green vapors. Ground-based cameras monitored their velocity and direction.

February 24 The British science journal *Nature* publishes a report by Cambridge University astronomers on their discovery of four pulsating radio sources. Initially, scientists speculated that the pulses might be some type of navigation or communication network designed by a highly advanced civilization. "The remarkable nature of these signals at first suggested an origin in terms of man-made transmissions," wrote Cambridge astronomer Antony Hewish. But after intensive study, scientists concluded that the speed and regularity of the signals were the first evidence of neutron stars, whose existence had been theorized since 1932. Rotating neutron stars, or pulsars, have the high spin rate and strong magnetic field needed to generate such powerful signals.

1977

March 10 When Uranus occults, or passes in front of, a bright star, astronomers in four locations discover that the planet has rings. Scientists aboard NASA's Kuiper Airborne Observatory got an especially long view of the occultation as they flew over the Indian Ocean, and they recorded the presence of five rings. In 1986 Voyager 2 imagery revealed the existence of 11 rings.

Crowded skies are leading to increased sales of the Boeing 757.

NASM

1982

February 19 Boeing's 757 airliner makes its first flight. Powered by fuel-efficient Rolls-Royce engines, the red, white, and blue twin-jet took off from Renton, Washington, and climbed out over Lake Washington, where it was joined by a Boeing-owned F-86 chase aircraft. Aside from a problem with the no. 2 engine, the two-and-a-half hour flight was uneventful. When Boeing first announced plans to develop the 757 in 1978, Airbus Industrie predicted little or no market for a 186-passenger aircraft, but by the end of 1988, with airlines favoring the larger transports in an effort to compensate for congested airways, almost 400 had been purchased.

. . . and Events

February 11–March 12
"Steichen and His Men: A Photographic Portrait of World War II." Images of carrier pilots, factory workers, Navy sailors, and civilians. Smithsonian Traveling Exhibition. At Gerald R. Ford Museum, Grand Rapids, MI, (616) 456-2674.

February 14–16
Aerospace Engineering Conference and Show, sponsored by the American Institute of Aeronautics and Astronautics. At Los Angeles Airport Hilton, Los Angeles, CA, (202) 646-7454.

February 19–April 16
"Visions of Flight: A Retrospective From the NASA Art Collection," Smithsonian Traveling Exhibition. At Huntsville Museum of Art, Huntsville, AL, (205) 535-4350.

February 20
Total lunar eclipse.*

March 4–April 2
"Black Wings: The American Black in Aviation," Smithsonian Traveling Exhibition. At Prairie View A&M University, Prairie View, TX, (409) 857-3311.

March 5–10
"Space Commercialization: Roles of Developing Countries," symposium sponsored by the American Institute of Aeronautics and Astronautics. At Stouffer Nashville Hotel, Nashville, TN, (615) 455-0631.

March 10–12
Valiant Air Command Warbird Airshow. Over 130 types of aircraft. At Space Center Executive Airport, Titusville, FL, (407) 268-1941.

March 20
Equinox occurs at 10:28 a.m. EST, marking the beginning of spring in the northern hemisphere.*

**Call the Smithsonian's Earth and Space report at (202) 357-2000 for recorded information on astronomical events.*

Organizations wishing to have events published in Calendar should submit them four months in advance to Calendar, Air & Space/Smithsonian, *National Air and Space Museum, Washington, DC, 20560. Events will be listed as space allows.*

—Diane Tedeschi

Painter to the Stars

When space artist Andreas Nottebohm lets his mind wander, it really wanders: it travels through space and through time, probes the depths of the unknown, reaches through vast stretches of the universe, and finally settles, amid swirls of acrylic paint, on a shimmering surface of aluminum.

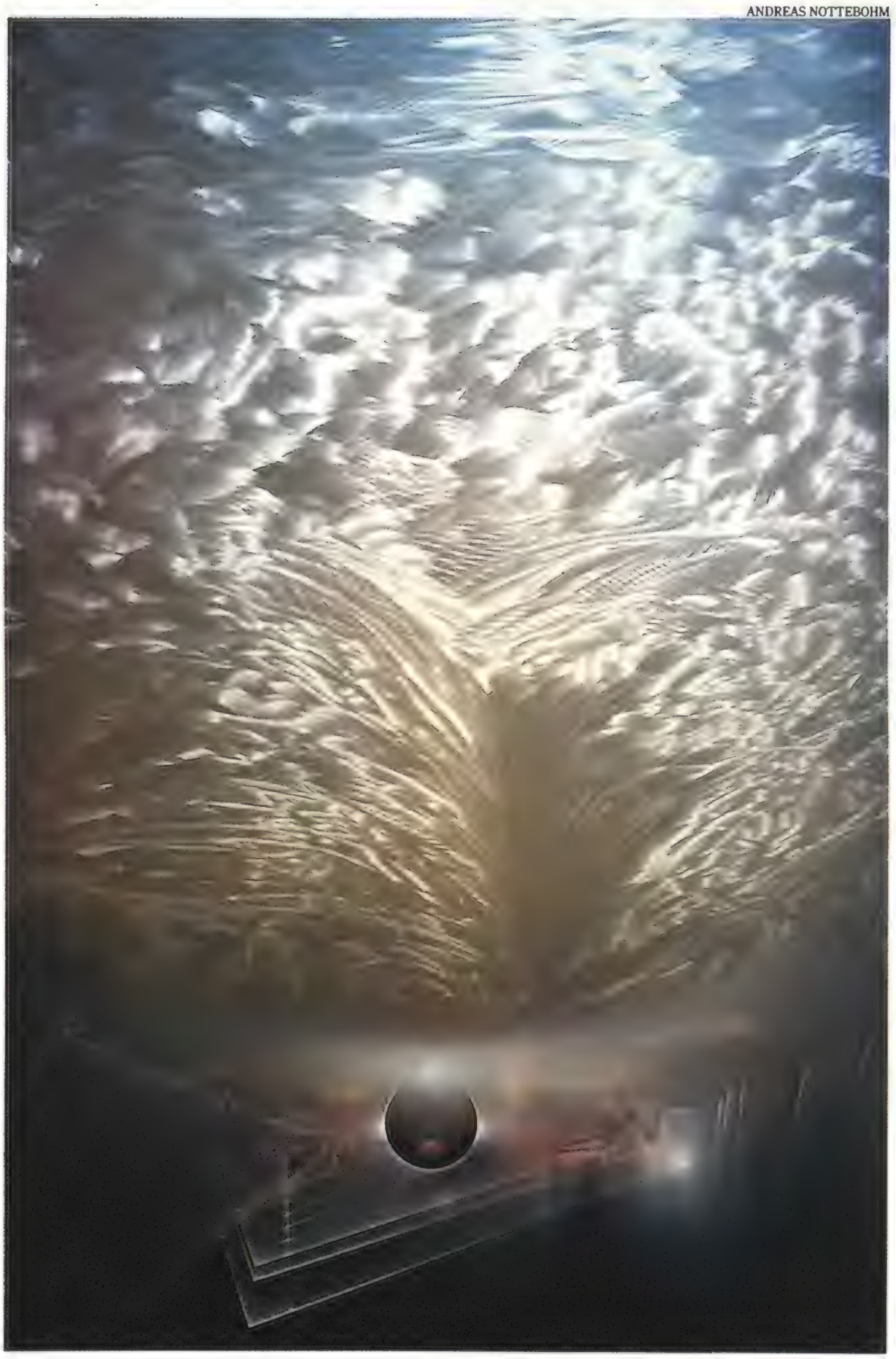
He prefers not to attempt to describe the results of these journeys, however. He doesn't even title his paintings, thinking that words have too little in common with art. "It's such a different medium than speech or literature or anything like that to combine the two," he says.

The German-born artist, who has created seven new paintings to be displayed in the Museum this March in conjunction with the opening of a new planetarium show, "Calling All Stars," doesn't mind describing what his paintings *aren't*: with a mixture of pride and amusement, Nottebohm notes, "I just had a show at Frankfurt in Germany, and a guy comes in with his little son and takes the son over to one of the paintings and says, 'And this, my son, is a hologram.' "

The unusual shimmering quality of Nottebohm's work comes from the aluminum surfaces he uses. Aluminum "can create light and movement that you cannot create with anything else," he says. "You know how the sun reflects on the water, and the reflections of the sun on the water always go with you? That's kind of the same effect; the lights that reflect on the aluminum, they move in front of your eyes, so you see one painting from one side and another painting from another side."

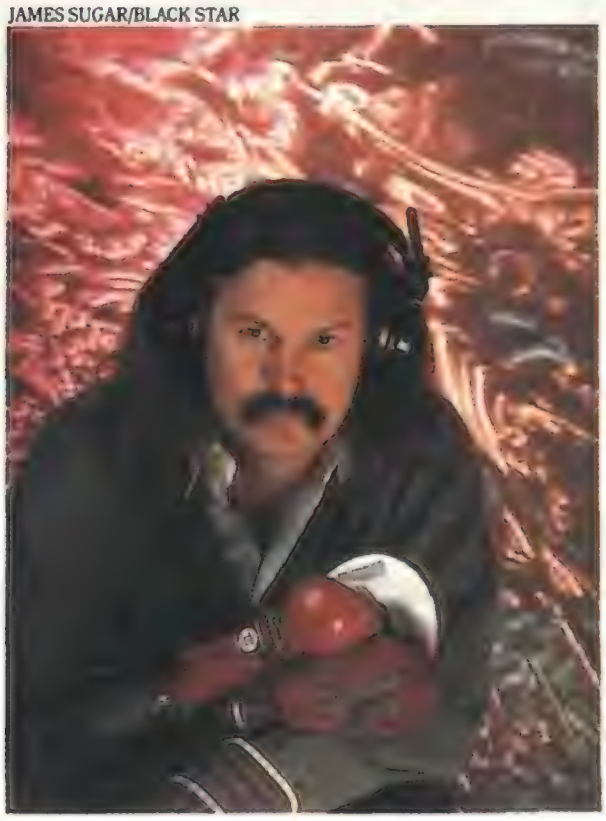
Before the artist begins painting, he readies the aluminum surface by burnishing patterns into it with a disk sander. The sander makes a lot of noise, though, which the artist insulates himself from with a healthy dose of music, via earphones. "People send me all kinds of space music, of course," he says, but the 44-year-old artist's tastes are eclectic. Maybe they have to be; he listens to music "nearly 23

ANDREAS NOTTEBOHM



Andreas Nottebohm's luminous paintings chronicle a mind's journey into space.

JAMES SUGAR/BLACK STAR



For Nottebohm, earphones are as essential as his other tools.

hours a day. I listen to a lot of classical music, but it changes. You know, one day I like to get up in the studio and I want to hear some country and western music for a few hours. And then I listen to Pink Floyd for a few hours or Dire Straits, and then I go back to classical again or listen to the radio. Music is a big part of my life."

He pursues his interest in space with an equal passion. "The way that he expresses the whole concept of space is very well done," says Mary Henderson, the Museum's curator of art. "He gives a sense of the vast, mysterious distances that you just don't find in other more realistic, representative work."

During his formative years, in the 1970s, the artist "hung out with a lot of scientists in Germany," where he was one of the co-founders of the Society for Art and Science in Munich. Around the time he moved to the United States he was invited to participate in the NASA Art Program and visit the Jet Propulsion Laboratory when Voyager 2 sent back images from its closest encounter with Saturn in August 1981. Nottebohm later witnessed four shuttle launches, which he calls "the most fantastic things I've ever seen."

For all his enthusiasm for the subject, however, he says many people see it as "too scary," preventing more widespread excitement over space and space exploration. Nottebohm says he understands that fear. "It took me years and years also to have no scared attitudes towards the universe, towards my environment—or to see the universe as my environment. I think that's one of the biggest steps in this whole thing, that you see that the universe is not something that's against you, but that it is what created you.

"Every little piece of material that you're made of is between 15 and 20 billion years old," adds the artist with a sense of wonder. "You're made out of the stuff the stars are made of."

—Karen Jensen

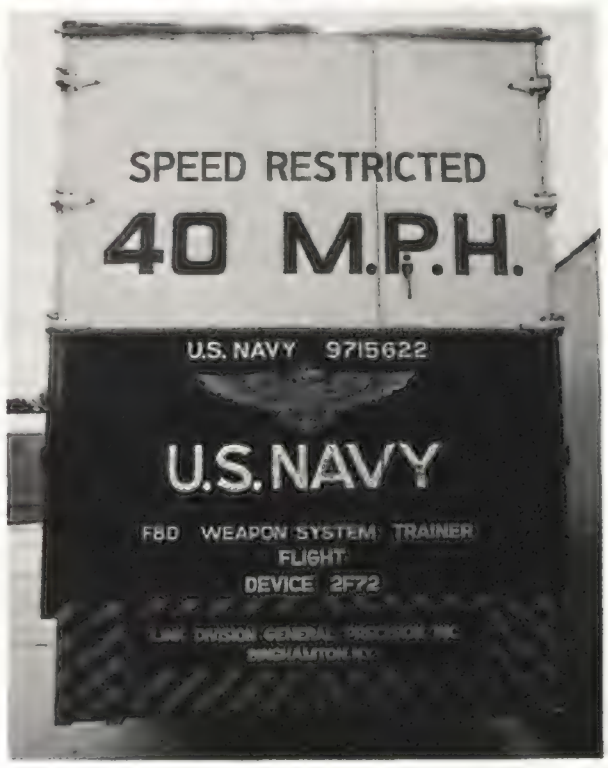
The Last Eight-Wheel Gunfighter in the Navy

It may not be the very image of speed (OK, so it isn't the image of speed at all; having "SPEED RESTRICTED 40 M.P.H." emblazoned on its rear doesn't help), but inside this mild-mannered hulk of a semi-trailer lies the heart of a jet fighter.

The 40-foot trailer, which the Navy gave to the Museum late last year, houses an F-8 flight simulator. The Vought F-8 Crusader, known as "the last gunfighter of the Navy," was equipped with cannons and machine guns rather than the rockets and missiles of today. The airplane's role peaked in the 1960s and early 1970s, and the F-8 was finally retired from Navy service a little over a year ago, the simulator along with it.

The rear of the trailer (known as the "cockpit zone" in training manual parlance) houses the nose and cockpit of an F-8; massive banks of computer and air conditioning equipment are stored up front. Between them is the "instructor's zone," where an instructor can monitor his trainee's performance—and plug in some spills and thrills to test his mettle.

It may look hopelessly earthbound, but this semi has much in common with a fighter.



NASM

According to Robert Mikesh, the Museum's senior curator of aeronautics, the F-8 simulator was the state of the art in the 1960s; today it represents the midpoint—maybe a little beyond it—of simulator technology. Although the simulator can't duplicate the physical feel of flight that today's advanced simulators offer, it can reproduce most aspects of flying. It has a few special effects up its sleeve, too: lightning that flashes outside the cockpit and red lights and bells that go off when it crashes.

And it has one big advantage over larger, more sophisticated simulators: its housing makes it highly portable. "Here is a flight simulator that is almost like a squadron mascot," Mikesh says. "It deploys with the unit and training can continue."

Indeed, the unit was designed for shipboard use, but persistent corrosion problems in its housing prevented it from ever going to sea. "It may have got down to the dock," where carrier flight crews could train while they were in port, "but that was about as far as it went," says John Shatz, a retired Air Force pilot and Museum volunteer who's been researching the simulator's background.

Its relatively compact form *has* proven a benefit to curators. The Museum was offered an F-106 simulator, Mikesh reports, but it was housed in a 50-foot-square building; the curator feared the Museum would come away with little "other than stored electronics parts for years to come." The F-8 simulator, currently on a driveway at the Museum's Paul E. Garber Preservation, Restoration and Storage Facility in Suitland, Maryland, offers a more convenient form for displaying the technology.

As a former Air Force pilot who spent many hours in simulators, Mikesh has a grudging affection for the contraptions. "You know you could open the canopy and walk out and get in your car and drive home right there if you want," he says. "But as far as you're concerned, the ceiling is 200 feet, and your fuel is getting down, your oil pressure is low . . . but you're going to pace this thing and make the best approach and landing ever."

Not bad—for a semi.

—Karen Jensen

Museum Calendar

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202) 357-2700 for details.

New Planetarium Show "Calling All Stars." The search for intelligent life in the

THE OFFICIAL MEDALLIC REGISTER

AMERICA

1969: The mission of Apollo 11 gives the United States a stunning victory in the race to the moon.

To commemorate the 20th anniversary of man's first moon landing, the National Space Society officially issues an unprecedented collection. Solid sterling silver medals capturing America's greatest breakthroughs in space.

Proof medals above shown enlarged to emphasize detail.

PHOTO COURTESY OF NASA

Proof medals at right shown actual size of 39mm in diameter.

IN SOLID STERLING SILVER

IN SPACE

1962: Mercury VI—America's first manned orbital flight of the earth.

1966: America sends unmanned orbiters to the moon to look for a suitable site for the first manned landing.

1971: The U.S. places the first man-driven vehicle on the moon —the Lunar Rover.

1981: The Space Shuttle Columbia, America's first reuseable spacecraft and the first to land on an airstrip.

From the first American satellite...to the "Eagle" that won the race to the moon...to the first space shuttle, this is the definitive record of America in space. Officially issued by the National Space Society to commemorate the 20th anniversary of America's victory in the race to the moon.

Our nation's greatest achievements in space are preserved in Proof quality solid sterling silver medals minted to perfection by The Franklin Mint. A legendary spacecraft is engraved and minted on the obverse of each medal. And the intricate inner workings appear on the reverse. The frosted detail standing out against the brilliantly polished background.

The entire collection of 25 Proof medals impressively displayed in the handsome collector's album, provided at no additional charge.

Each solid sterling silver Proof medal is $29.50. And the handsome collector's album is provided at no additional charge.

SUBSCRIPTION APPLICATION

Please mail by March 31, 1989.

The National Space Society
c/o The Franklin Mint · Franklin Center, Pennsylvania 19091

Please enter my subscription for The Official Medallic Register of America in Space, consisting of twenty-five Proof medals (39mm in diameter), minted in solid sterling silver, which will be sent to me at the convenient rate of one each month.

No payment is required at this time. Please bill me $29.50* for each Proof medal, with the first payment due in advance of shipment. A hardbound collector's album will be provided at no additional charge. **Plus my state sales tax and $1. for shipping and handling.*

AN OFFICIAL ISSUE
OF THE
NATIONAL SPACE SOCIETY

SIGNATURE _____
ALL APPLICATIONS ARE SUBJECT TO ACCEPTANCE

NAME _____
PLEASE PRINT CLEARLY

ADDRESS _____

CITY _____

STATE, ZIP _____

12063 -4

universe. Continuous showings beginning March 10; admission fee. Einstein Planetarium.

Smithsonian Astrophysical Observatory Lecture Series Four-week series on the scientific search for extraterrestrial intelligence. Wednesdays, March 15, 22, 29, and April 5. Einstein Planetarium, 7:30 p.m.

"Out of This World" Cartoon Classics Series Theme: "Aliens in a Strange Land." Saturdays, March 11, 18, and 25. Einstein Planetarium, 9:30 a.m.

"The Computer Generation" Film Series *Tron,* February 3; *Explorers,* February 10; *The Last Starfighter,* February 17; *Flight of the Navigator,* February 24; *Star Trek IV: The Voyage Home* ($1 admission), March 3. Langley Theater, 7:30 p.m.

February 8 Exploring Space Lecture Series: "A Search for Planets." Bruce Campbell, University of Victoria, British Columbia. Langley Theater, 7:30 p.m.

February 16 General Electric Aviation Lecture: Lt. Gen. Frank E. Peterson Jr. (USMC, Ret.), who in 1952 became the Marines' first black pilot and later the defense department's senior-ranking aviator. Langley Theater, 7:30 p.m.

February 21 Black History Month Lecture: "Dallas to Madrid: Reflections of a Black Airline Pilot." David Harris, Boeing 767 pilot. Langley Theater, 7:30 p.m.

February 25 Kite display, lecture, and distribution of rules for the Smithsonian Kite Festival (see March 18 listing). Tickets are free but must be obtained in advance. For information, call (202) 357-3030. National Museum of Natural History, Baird Auditorium, 10 a.m.

March 8 Exploring Space Lecture Series: "White and Brown Dwarf Stars." Harry Shipman, University of Delaware. Einstein Planetarium, 7:30 p.m.

March 18 23rd Annual Smithsonian Kite Festival. Handmade kite competition. Washington Monument grounds, west side, 10 a.m. (Rain date: March 19.) For more information call (202) 357-3030.

March 23 General Electric Aviation Lecture: "Escape From Laos." Eugene Deatrick and Dieter Dengler, on a daring rescue from a Cambodian prison camp. Langley Theater, 7:30 p.m.

THE WORLD AT WAR

The renowned World War II documentary is available for your home video collection. Whirlwind is your introduction for just

$4.95 plus shipping and handling

In the winter of 1940, London withstood Luftwaffe bombing 76 nights in succession. While the public cried for revenge, British aircrews trained to fly in daylight took brutal losses flying deep into Germany in the dark, hunting for targets that would knock out Nazi industrial production.

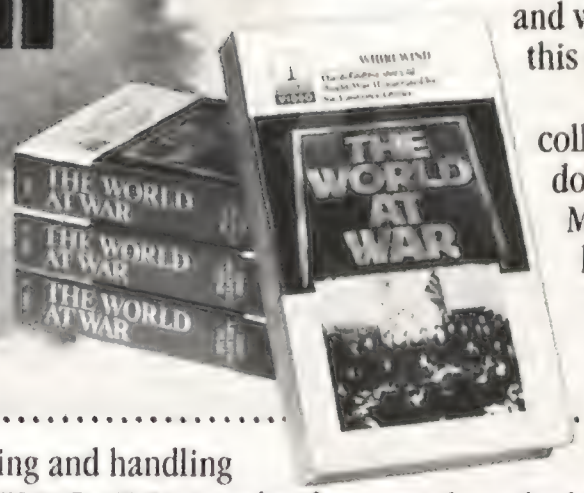
Arthur Harris took charge of Bomber Command, determined to succeed with new tactics and new bombers:

"They have sown the wind and now shall reap the whirlwind."

Whirlwind, the story of the long years it took to establish Allied air superiority, is your introduction to THE WORLD AT WAR.

Preview it at home for 10 days. Return it and owe nothing. Or keep it and look forward to future cassettes in THE WORLD AT WAR series, one every four to six weeks, to keep for $29.95 plus shipping and handling.

Each volume of this dramatic documentary is narrated by Sir Laurence Olivier and combines action footages from the fronts and the war rooms with penetrating eyewitness interviews with statesmen and military leaders as well as ordinary men and women who lived through this momentous conflict.



Start your home video collection of this historic documentary series today. Mail the coupon below or have your credit card ready and call toll-free 1-800-CBS-4804.

☐ YES, send me Whirlwind for only $4.95 plus $2.45 shipping and handling (and applicable sales tax) and enter my subscription to THE WORLD AT WAR under the terms described in this ad.

Check one: ☐ VHS ☐ Beta

Check method of payment: ☐ Check enclosed made payable to WORLD AT WAR. E11

☐ Charge my WORLD AT WAR purchases, beginning with my first cassette to: ☐ American Express ☐ VISA ☐ MasterCard ☐ Diners Club E12

Account No. _____ Exp. Date _____

Signature _____

Phone Number _____

Name _____

Address _____ Apt. _____

City _____ State _____ Zip _____

If I do not choose to keep my first cassette, I will return it within 10 days for a full refund or for credit to my charge account. Note: All subscriptions subject to review. We reserve the right to reject or cancel any subscription. Canadian residents will be serviced from Toronto. Applicable sales tax added to all orders.

Mail to: THE WORLD AT WAR, Dept. EBC, 1400 No. Fruitridge Avenue, P.O. Box 1112, Terre Haute, IN 47811

George On My Mind

ILLUSTRATIONS BY MICHAEL DAVID BROWN

George Kronovich was a memorable individual—probably the most memorable I have ever encountered. This wasn't a singular appraisal. Everyone agreed that he was a little loopy.

Our paths crossed in 1949 at the Douglas Aircraft Company in El Segundo, California, where I was working as a flight line mechanic. It was my first real job in aviation—I was fresh out of aeronautics school with an airframe-and-engine mechanic's license and a pilot's license to boot.

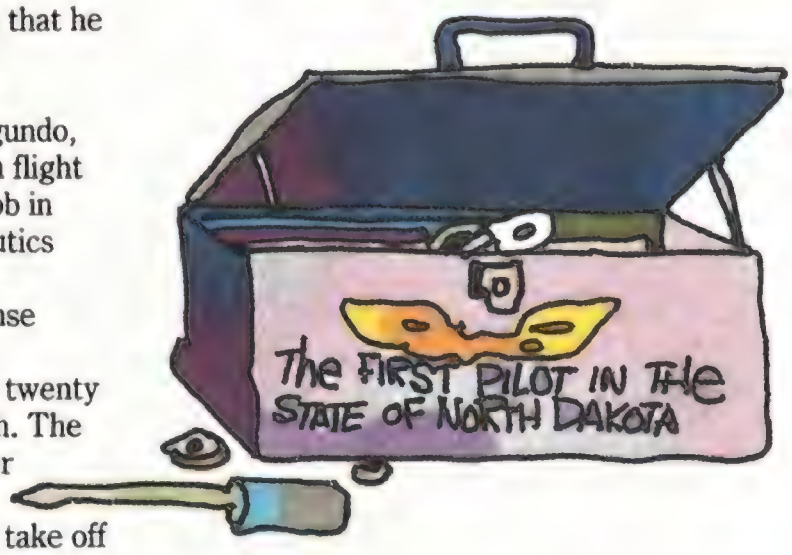
Douglas was cranking out around twenty AD Skyraider dive-bombers a month. The AD was a great airplane. Any carrier aircraft that would obligingly get airborne when a green pilot tried to take off with its wings folded had to be great.

We worked the swing shift, so most of our work was done outside by the glare of floodlights placed on the ground next to each aircraft. They illuminated the engine and propeller but not the works underneath the engine cowling. We carried flashlights, and in an effort to bring both hands to bear on a job we would tuck the flashlight in an armpit, lay it on the engine, or wedge it between oil hoses.

George had a better idea. He wore a flashlight on his head. The batteries were stored in a rear coverall pocket, and wires ran from the battery pack up his torso. A switch on the pack turned it on and off but George seldom used it. He turned the flashlight on when he arrived, and as the evening progressed and the batteries ran down, the light would become progressively dimmer until it was only a glow. You could judge quitting time by the weak glimmer of George's head-mounted contraption. The next evening he would replace the batteries and repeat the cycle.

George always looked you right in the face when he talked—and he talked incessantly—which put the flashlight's bright beam directly into your eyes. It was like conversing with an oncoming locomotive. It also ruined your dark-adapted vision, which was particularly disconcerting if you were balanced on a ladder.

Sometimes, when George was preoccupied with a task, we would reach behind him and clip his wires. When his light went out, he'd look puzzled, take off the headband assembly, rap it on something, and mumble. Then he'd climb down the ladder, remove the battery pack, spot the clipped wires, sigh mightily, and patiently splice them together with black friction tape.

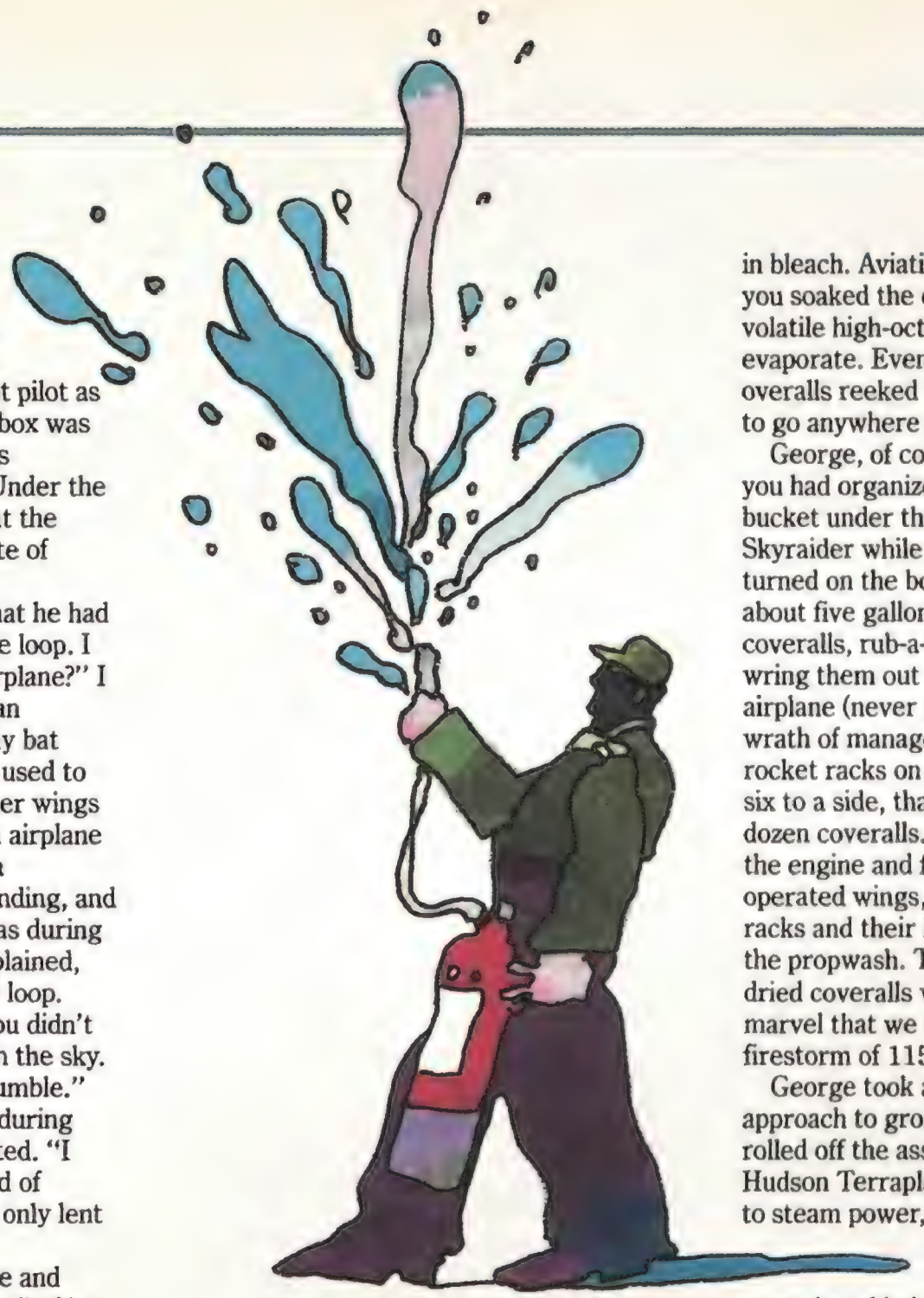


One night, while he was bleeding air from the brakes on a Skyraider, the tables turned on George and his spotlight. Strolling down the line was our lead man—a liaison between management and mechanics—out for his evening constitutional, during which he always greeted each of us by name. George was just arising from a squat beside the right brake and was transferring his tools to the left side when the lead man reached his aircraft. The glare of the floodlights on either side of the Skyraider evidently blinded George, who collided head-first with the trailing edge of the stationary propeller blade.

He dropped like a felled tree and ended up on his knees, his face against the ground and his arms outstretched like a Muslim at prayer. The lead man called out, "Good evening, George" and continued down the line before realizing all was not well. He paused, then whirled and stared. "Oh my God!" he shouted, rushing to the inert form and yanking George's head up by his hair. One look at the bloodied face and the lead man dropped George's head back on the concrete, yelled "I'll go get help!" and collided with the same propeller blade. He fell into echelon formation behind George.

George came to regard fire extinguishers with the same wariness he now showed toward propellers. One night he was serving as fire guard for an engine run-up man who had managed to get a dandy little fire going in the exhaust stacks. No man of indecision, George raised the horn of the large carbon dioxide bottle, aimed it at one of the upper stacks, and opened the valve.

George hadn't checked the horn before firing so he had no way of knowing it was stuffed full of soiled rags. Pressure built up and abruptly blew the horn completely off the extinguisher's hose. George was left with the stub end of the fitting in his hand, blasting CO_2 and looking for all the world like a Roman candle. To add injury to insult, as he stared stupidly at the belching fitting,



the discharge horn, completing its trajectory, struck the side of the engine cowling, ricocheted, and smacked him in the forehead.

George considered himself a hot pilot as well as a crack mechanic. His toolbox was emblazoned with a big set of wings fashioned from gold-colored foil. Under the wings was his name and under that the legend "The First Pilot in the State of North Dakota."

George one day informed me that he had performed the world's first outside loop. I was intrigued. "In what kind of airplane?" I asked. "Who said anything about an airplane?" he said. "I did it with my bat wings." George explained that he used to strap on a pair of homemade leather wings with stiffening ribs, jump out of an airplane at airshows, glide gracefully, pop a parachute, make a feather-light landing, and bow to the awestruck crowd. It was during one of these performances, he explained, that he had performed the outside loop.

"But, George," I protested, "you didn't actually describe an outside loop in the sky. You were only in a slow forward tumble."

"No, I actually *gained* altitude during the backside of the loop," he insisted. "I wore an altimeter, so I know." End of discussion—arguing with George only lent credibility to his claim.

Each airplane had a maintenance and inspection book in which every detail of its existence was noted. When an airplane was on the ground the three-ring binder was kept in the engine oil-cooler scoop for the convenience of the maintenance crew. You just reached up, grabbed the book, wrote down the work done, and tossed it back in the scoop.

One evening George preflighted a Skyraider, strapped the pilot in for a test flight, and signaled him clear to taxi. The pilot returned after an abnormally brief flight. He had experienced a dramatic rise in engine oil temperature, he told George. "Well, we'll just put that down in the book," George said, whereupon he reached into the oil-cooler scoop, brought forth the book, and began writing. After 30 minutes of flight, not a page was torn or even wrinkled. (Soon thereafter, a bright yellow book box appeared on the Skyraider's left inboard ordnance rack.)

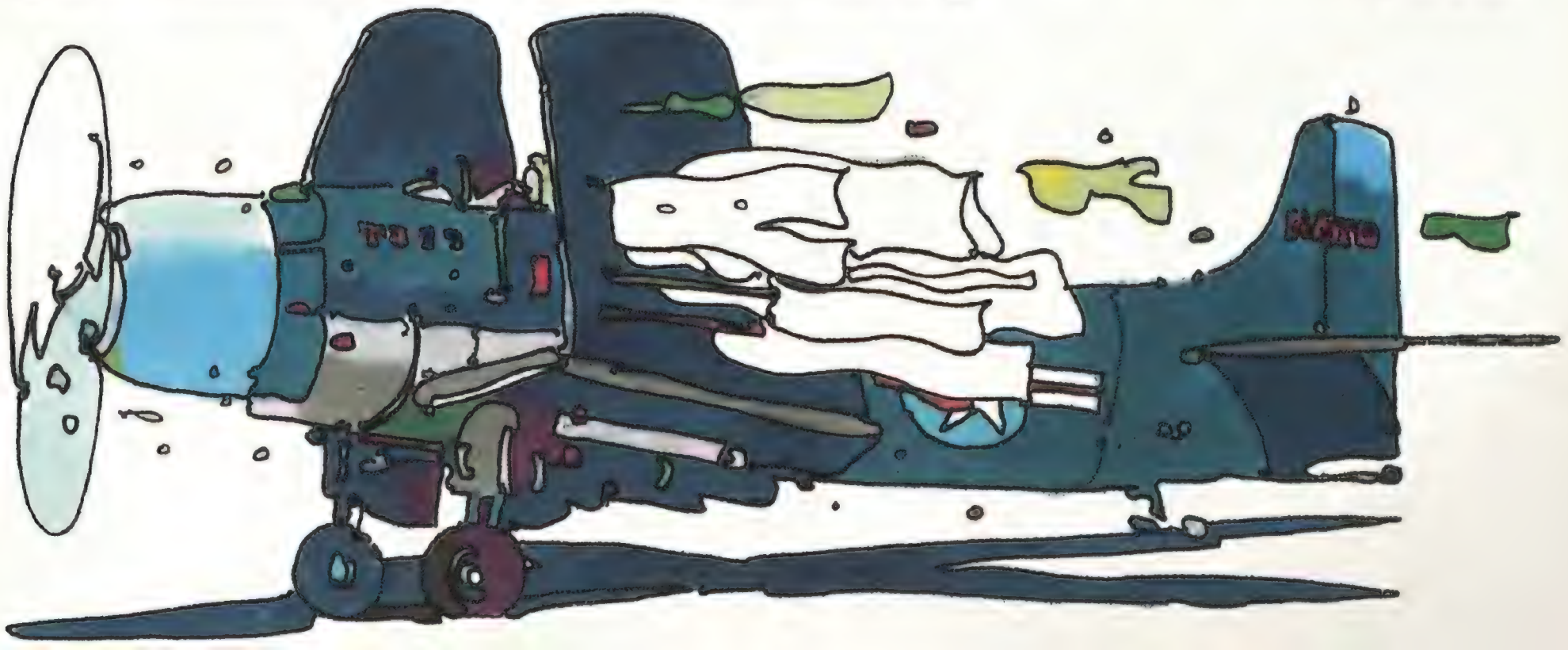
Most of us wore white coveralls on the job, hardly a practical color. Engine oil resisted removal despite repeated soakings in bleach. Aviation gas would do wonders if you soaked the overalls in it, but the very volatile high-octane fuel took some time to evaporate. Even when they felt dry the overalls reeked of gasoline. You were afraid to go anywhere near a lit cigarette.

George, of course, had the solution. Once you had organized a wash day you held a bucket under the fuel strainer drain in the Skyraider while someone in the cockpit turned on the boost pumps. When you had about five gallons you would add the coveralls, rub-a-dub-dub for a while, then wring them out and take them to George's airplane (never our own, as we feared the wrath of management). The Skyraider had rocket racks on the underside of the wings, six to a side, that neatly accommodated a dozen coveralls. George would then fire up the engine and fold the hydraulically operated wings, which brought the rocket racks and their load of laundry directly into the propwash. Ten minutes later the blow-dried coveralls were retrieved. (I now marvel that we weren't immolated in a firestorm of 115/145 octane avgas.)

George took a similarly inventive approach to ground transportation. What rolled off the assembly line as a 1937 Hudson Terraplane George had converted to steam power, all by himself. He claimed to have a steam engineer's license—a federal requirement, he added. A maze of pipes and valves ran under the Hudson's body and hood and even through the trunk. And on each side of the hood was a miniature replica of the gold wings on George's toolbox, complete with legend.

After work, while all the cars poured out of the parking lot, the first pilot in the state of North Dakota would be sitting there working up a head of steam. He said it didn't take long—the Hudson had a flash boiler. We never waited around to find out.

—O.H. Billmann



Southern Comfort

The trouble started when I left my suit coat in Hattiesburg, Mississippi. I managed to leave the old tan jacket with worn buttonholes hanging over the plastic back of an airport terminal chair. Actually, I hated the damn thing. But I had brought it in response to an elegant invitation I received last May to come to Arlington, Texas, for "the official rollout of the revolutionary V-22 Osprey aircraft, America's newest defense achievement."

Having a soft spot for revolutions and dusty memories of defending America, I accepted the offer. Vertical-lift aircraft fascinate me, and this one, built by Bell Helicopter Textron and Boeing Helicopters, seemed especially intriguing, with its short, wide rotor blades that tilt forward to become propellers for horizontal flight. There have been several attempts to build a craft that combines the best features of the helicopter and the airplane, but the Osprey tilt rotor will be the first in mass-production.

There was to be a reception the night before the rollout and a power breakfast the next morning. "Business attire for all functions," the invitation warned. Hence the tan jacket and an old striped tie.

Since the jacket had decided to remain in the Deep South, I faced the grandeur of Fort Worth's Worthington Hotel in a nice clean shirt. Thanks to a delayed flight I was too late for the reception. Just as well—shirtsleeves might have seemed gauche. Surely, however, they'd pass muster at tomorrow's breakfast. After all, this was Texas, where folks wore cowboy boots, big hats, and decorated shoelaces around their collars. I'd knock 'em flat with my eastern establishment tie.

In the elevator the next morning everyone sported an identification card on the pocket of some sort of jacket. Members of the Bell-Boeing team wore dark pinstripe suits. Others wore blue blazers with khaki slacks or khaki jackets with dark slacks. Writers for eastern magazines wore tan suits with jackets somewhat less shabby than the one I'd left in Hattiesburg.

Edging to the rear of the elevator, I removed my ID card and tried to look like a linoleum salesman from Oklahoma City. I chickened out on the VIP breakfast and found a coffee shop, where a contemptuous waitress took my order.

At least I'll be all right at the Bell hangar, I thought. The Texas sun will have all those jackets off in a jiffy. On the bus to Arlington, my seatmate wore a four-button blazer, regimental tie, and hundred-dollar shoes.

"I left my jacket in Hattiesburg, Mississippi," I blurted.

"Oh?" he said. Conversation flagged. Outside the hangar, jackets stayed on despite the bright morning sun. I hid in the crowd of 2,000 or so until I spotted three men in shirtsleeves. I hastened over to these fellow nonconformists, who turned out to be a Navy vice admiral, an Air Force major general, and a Marine colonel, all chatting in computerese. I disappeared back into the crowd.

When the lights dimmed in the hangar my confidence returned. General Alfred M. Gray Jr., commandant of the U.S. Marine Corps, the service that has ordered the lion's share of the Ospreys, briefed us on the significance of the V-22. Back in World War I, the Marines took on the nickname "Devil Dogs" and chose as their mascot a fierce-looking bulldog in a dishpan helmet. General Gray is its spitting image, with his strong, square face, pugnacious jaw, and tendency to bark words like "assault" and "strike" and "force." When the general sounded off, I paid attention.

I learned that vertical lift is a must for today's Marines, that they need to attack fast from beyond the horizon, striking where least expected, sometimes changing targets at the last moment. The Osprey, built largely from composites, will oblige with a top speed of nearly 350 mph, a 1,000-mile range, and the ability to land on rough or sloping ground or hover while carrying 24 troops or 15,000 pounds of cargo.

At the conclusion of Gray's oratory the curtains parted and we caught a glimpse of the dramatically backlit V-22 with its engine nacelles and fat, wide rotor blades tilting from the forward to the upright position. I couldn't see much, though, since I didn't feel like standing on my chair in shirtsleeves with the general there to bark at me.

When an Osprey is brought up from below-deck storage to the flight deck of an aircraft carrier, it resembles a trailer laden with wreckage from a car crash—a 62- by 17-foot rectangle of junk on landing gear. Then, with a hum, a 90-second metamorphosis commences.

The mess on top of the fuselage begins

YVONNE GENSUROWSKY/SRW, INC. (2)

to rotate and sort itself out. Part of it becomes a stubby 46-foot wing. Then the cluttered nacelles slowly swing upright. Finally, the two tangles of blades turn on their shafts and click smoothly into place as 38-foot three-blade rotors.

Today, though, we had to be content with the Osprey merely tilting its rotors from the airplane to the helicopter position. Soon a Marine band thumped and a thousand cameras whirred and snapped as a tractor dragged it into the sunlight. I'd have loved to see it fly. But that's another ceremony altogether.

On the bus back to the hotel everyone shared views on the Osprey, Fort Worth, and the local cuisine. "Hey, that was a great show . . . " "It can't replace the Harrier . . . " "It sure could replace this bus ride . . . " "I got a look at the cockpit. Nice, simple setup . . . " "Did y'all get some of that barbecue last night? Mm-*mm*! . . . " "Man, it sure is great to finally get this *jacket* off!"

—*Edwards Park*

WYNTON·TO·WINWOOD

TAKE ANY 8 COMPACT DISCS FOR 1¢ plus shipping and handling with membership

Wynton Marsalis—Portrait Of Wynton Marsalis. (CBS Masterworks) **373555**

U2—Rattle And Hum. (Island) **374017**

The Movies Go To The Opera —Various Artists. (Angel) **372342**

Luciano Pavarotti—Pavarotti In Concert. (CBS Masterworks) **373548**

Steve Winwood—Roll With It. (Virgin) **371211**

Dianne Schuur—Talkin' 'Bout You (GRP) 374298

Mieczyslaw Horszowski—Mozart/Chopin/Schumann (Nonesuch) 373902

One Moment In Time—1988 Summer Olympics Album—Various Artists (Arista) 373811

Cocktail—Original Sound Track (Elektra) 373779

Bird—Original Motion Picture Soundtrack (Columbia) 373332

Emanuel Ax—Chopin: 4 Scherzos, Mazurkas (CBS Master.) 372466

Jean-Pierre Rampal—Portrait Of Rampal (CBS Master.) 372383

Kenny G—Silhouette (Arista) 371559

Huey Lewis And The News—Small World (Chrysalis) 371419

The Bernstein Songbook—selection from West Side Story, On The Town, etc. Bernstein cond. (CBS) 371088

Zubin Mehta, Cond.—Rimsky-Korsakov: Scheherazade/Russian Easter Overture Israel Philharmonic Orchestra (CBS Master.) 371021

Spyro Gyra—Rites of Summer (MCA) 370767

Elton John—Reg Strikes Back (MCA) 370536

Enoch Light & The Light Brigade—The Big Bands Of The Thirties (Project 3) 341263

Michael Crawford—Songs From Stage & Screen (Columbia) 370411

Robert Palmer—Heavy Nova ((EMI)) 370395

David Sanborn—Close Up (Warner Bros.) 370304

Tracy Chapman (Elektra) 369892

Schumann-Cello Concerto.—Yo-Yo Ma; Davis, Bavarian Radio Sym. Orch. (CBS Master.) 369843

John Williams—The Baroque Album (CBS Masterworks) 369769

Claude Bolling, Piano—Bolling's Greatest Hits (CBS) 369751

Richard Marx (EMI) 369611

Van Halen—OU812 (Warner Bros.) 369371

Michael Feinstein—Remember: Michael Feinstein Sings Irving Berlin (Elektra) 369322

Bobby McFerrin—Simple Pleasures (EMI) 369306

Basia—Time And Tides (Epic) 368043

Sade—Stronger Than Pride (Epic) 368027

Brahms—Double Concerto. Isaac Stern, Yo-Yo Ma; Abbado, Chicago Sym. (CBS Master.) 367250

Sinead O'Connor—The Lion and The Cobra (Chrysalis) 367086

Beethoven—Sonatas "Moonlight" and "Appassionata." Andre Watts (Angel) 366815

Mendelssohn—Violin Concerto; **Saint-Saens:** Intr. & Rondo Capriccioso; **Massenet:** Meditation. Nadja Salerno-Sonnenberg (Angel) 366872

Canadian Brass—Bach: Art Of The Fugue (CBS Master.) 366740

Mozart:—Symphonies Nos. 31 & 36; Don Giovanni Overture. E. Batiz, con. (Varese Sarabande) 366708

Carly Simon—Greatest Hits Live (Arista) 365874

Beethoven—Symphony No. 9. Norrington, The London Classical Players (Angel) 365619

Placido Domingo—A Love Until the End of Time Ricardo Muti, cond. (CBS) 365262

Bruce Springsteen—Tunnel Of Love (Columbia) 360115

Beethoven: Overtures—Bavarian Radio Orch.; C. Davis, Cond. (CBS Master.) 345199

Wynton Marsalis—Baroque Music For Trumpets. (CBS Master.) 364695

Andres Segovia Collection, Vol. 1 Music By Bach (MCA Classics) 362293

George Michael—Faith (Columbia) 362228

Michael Jackson—Bad (Epic) 362079

Sting—...Nothing Like The Sun (A&M) 361675

INXS—Kick (Atlantic) 361519

Tchaikovsky Waltzes—Comissiona, Houston Sym. (Pro Arte) 357871

Beethoven—Piano Conc. No. 5. Perahia; Haitink, Concertgebouw Orch. (CBS Master.) 357657

Brahms—Piano Pieces, Op. 76 & 119; Fantasies Op. 116. Richard Goode (Nonesuch) 357145

Gloria Estefan & Miami Sound Machine—Let It Loose (Epic) 356279

Whitney Houston—Whitney (Arista) 356154

Pierre Boulez, Cond.—Stravinsky: The Firebird The Song Of The Nightingale New York Philharmonic (CBS Master.) 355776

Vladimir Horowitz, Piano—Favorite Encores (CBS Masterworks) 355164

Johnny Mathis/Henry Mancini—The Hollywood Musicals (Columbia) 349985

Mahler—Symphony No. 1 Maazel, Vienna Phil. (CBS Master.) 349936

Linda Ronstadt—'Round Midnight with Nelson Riddle And His Orch. (Asylum) 348987-398982

Pachelbel Canon—Other Digital Delights. Davis, Toronto Chamber Orch. (Fanfare) 348649

The Police—Every Breath You Take... The Singles (A&M) 348318

A Decade Of Steely Dan (MCA) 341073

Buddy Holly—From The Orig. Master Tapes (MCA) 348110

Dvorak—New World Symph. Batiz, London Phil. (Varese Sarab.) 346809

The Beach Boys—Made In U.S.A. (Capitol) 346445

Vivaldi—The 4 Seasons. Maazel, Members Of The French Nat'l Orch. (CBS Master.) 343715

Bach:—Goldberg Variations Glenn Gould, Piano (CBS Master.) 343251

Tchaikovsky—Eugene Onegin. Seiji Ozawa, Berlin Phil. (Angel) 343244

Barbra Streisand—The Broadway Album (Columbia) 342097

Kiri Te Kanawa—Sings Gershwin (Angel) 359745

Enoch Light & The Light Brigade—The Big Bands Of The Thirties (Project 3) 341263

Puccini Heroines.—Kiri Te Kanawa, Eva Marton, etc. (CBS Master.) 339242

Gershwin—Rhapsody In Blue; etc. Tilson Thomas, L.A. Philharmonic (CBS Master.) 339226

Pinchas Zukerman—Recorded Live In Israel! Tchaikovsky: Violin Concerto/Serenade Melancolique Melodie/ Israel Phil/Mehta, Cond. (CBS Master.) 336461

Berlioz—Symphonie Fantastique. Daniel Barenboim, Berlin Phil. (CBS Master.) 335547

Tchaikovsky—Suites From The Ballets: Swan Lake & Sleeping Beauty. Muti, Philadelphia Orch. (Angel) 334680

Brahms—Symphony No. 1 In C Minor. Klaus Tennstedt, London Philharmonic Orchestra (Angel) 332668

Zubin Mehta, Cond.—Prokofiev: Peter And The Wolf Saint-Sains: Carnival Of The Animals Perlman/ Katia & Mariello Labeque Israel Philharmonic Orch. (Angel) 331322

Ravel—Bolero, Etc. Maazel, Orch. Nat'l De France (CBS Master.) 324822

Wagner—Orchestral Music. Mehta, N.Y. Phil. (CBS Master) 323733

Beethoven—Symphony No. 5; Schubert: Symphony No. 8 Maazel, Vienna Phil. (CBS Master) 321570

Air Supply—Greatest Hits (Arista) 321307

Motown's 25 #1 Hits (Motown) 319996-399998

Neil Diamond—12 Greatest Hits, Vol. II (Columbia) 314443

Creedence Clearwater Revival—20 Greatest Hits (Fantasy) 308049

Barry Manilow—Greatest Hits (Arista) 288670

Eagles—Greatest Hits 1971-1975 (Asylum) 287003

Simon & Garfunkel—Greatest Hits (Columbia) 219477

The age of CD sound is here—and you have a practical new way to find the CDs you want. As your introduction to the CBS Compact Disc Club, you can choose any 8 CDs listed in this ad for 1¢. Fill in and mail the application—we'll send your CDs and bill you for 1¢ plus shipping and handling. You simply agree to buy 6 more CDs (at regular Club prices) in the next three years—and you may then cancel your membership anytime after doing so.

How the Club works: About every four weeks (13 times a year) you'll receive the Club's music magazine, which describes the Selection of the Month... plus new hits and old favorites from every field of music. In addition, up to six times a year, you may receive offers of Special Selections, usually at a discount off regular Club prices, for a total of up to 19 buying opportunities.

If you wish to receive the Selection of the Month, you need do nothing—it will be shipped automatically. If you prefer an alternate selection, or none at all, fill in the response card always provided and mail it by the date specified. You will always have at least 10 days in which to make your decision. If you ever receive any Selection without having 10 days to decide, you may return it at our expense.

The CDs you order during your membership will be billed at regular Club prices, which currently are $12.98 to $15.98—plus shipping and handling. (Multiple-unit sets may be somewhat higher.) After completing your enrollment agreement you may cancel membership at any time; if you decide to continue as a member, you'll be eligible for our money-saving bonus plan. It lets you buy one CD at half price for each CD you buy at regular Club prices.

10-Day Free Trial: We'll send details of the Club's operation with your introductory shipment. If you are not satisfied for any reason whatsoever, just return everything within 10 days and you will have no further obligation. So why not choose 8 CDs for 1¢ right now?

ADVANCE BONUS OFFER: As a special offer to new members, take one additional Compact Disc right now and pay only $6.95. It's a chance to get a ninth selection at a super low price!

Selections with two numbers contain 2 CDs and count as 2—so write in both numbers.

CBS COMPACT DISC CLUB: Terre Haute, IN 47811

CBS COMPACT DISC CLUB, 1400 N. Fruitridge 055/589
P.O. Box 1129, Terre Haute, Indiana 47811-1129

Please accept my membership application under the terms outlined in this advertisement. Send me the 8 Compact Discs listed here and bill me 1¢ plus shipping and handling for all eight. I agree to buy six more selections at regular Club prices in the coming three years—and may cancel my membership at any time after doing so.

SEND ME THESE 8 CDs FOR 1¢		

My main musical interest is (check one): *(But I may always choose from any category)*

☐ **Hard Rock** *Van Halen, U2*
☐ **Soft Rock** *Steve Winwood, Fleetwood Mac*
☐ **Jazz** *Kenny G., Spyro Gyra*
☐ **Easy Listening/Pop** *Barry Manilow, Barbra Streisand, Johnny Mathis, Ray Conniff*
☐ **Classical*** *Vladimir Horowitz, Yo-Yo Ma*

Mr. / Mrs. / Miss _____
Print First Name Initial Last Name

Address _____ Apt. _____

City _____

State _____ Zip _____

Do you have a VCR? (04) ☐ Yes ☐ No
Do you have a credit card? (03) ☐ Yes ☐ No 2ZE/F6 2ZF/F7

ADVANCE BONUS OFFER: Also send me one more CD right now at the super low price of just $6.95, which will be billed to me. ☐

Note: we reserve the right to reject any application or cancel any membership. These offers not available in APO, FPO, Alaska, Hawaii, Puerto Rico; write for details of alternative offer. Canadian residents serviced from Toronto. Applicable sales tax added to all orders. *Classical members serviced by the CBS Classical Club.

LEE BATTAGLIA

The Place-That-Looks-Like-Mars Mission

U.S. and Soviet artists launched a space mission of their own—from Iceland.

Air force general Alexei Leonov gets into Icelandic geology more literally than Yuri Orlov and the other artists.

by J. Kelly Beatty

It had been a long day—even by Iceland's summer standard—for the itinerant band of U.S. and Soviet artists. One had almost been swallowed up, sketchbook and all, by a crack in the glacial ice. Then the artists' bus got stuck in soft sand in an area they'd been warned to avoid. With half the group shouting "Push!" and the other "*Davai*!" a score of grunting

bodies finally rocked the bus free. It was East-West cooperation at its most basic.

Reaching camp, the group scattered for a last sketch before dinner. A leaden sky dulled the colors in the ice-draped hillsides, and the gray light exaggerated the unearthliness of the desolate surroundings. Roughly 10,000 years ago, massive glacial slabs receded from this place in three directions, uncovering a scoured landscape of dark volcanic outpourings. One could easily imagine this scene on Mars, or the moon, or a planet orbiting a distant star. And the artists, now just silhouettes in the dusk, were busy doing so. They had come to this dynamic island precisely because it looks so little like Earth.

Space artists have a problem: they cannot work on location. They create scenes from other planets and other solar systems and depict events in the history and the future of the universe "by putting facts, figures, photos, and fantasies together," says William Hartmann, an Arizona astronomer and artist who has published several astronomy texts as well as books of planetary paintings. Occasional field trips to otherworldly locales like Iceland, and before that, the Hawaiian lava fields and Death Valley, inspire them. They study land formations that help them produce astronomically convincing scenery, and they exchange ideas and techniques with the few other people who paint worlds they have never seen. "There's a bonding that occurs," observes Hartmann, "when you get with people who finally understand what you're trying to do."

In 1983, those who went on the Death Valley trip formed the International Association for Astronomical Arts, a loose confederation of several dozen Americans and a handful of others worldwide, intended to promote and hearten this tiny subset while their genre awaits recognition by the broader art community. In 1987 several members traveled to Moscow to exhibit their work at the Space Future Forum as guests of a Soviet organization: the 22,000-member Union of Artists (UOA). Sure enough, the bonding that Hartmann describes started to happen in Moscow. Hoping that it would continue, the Americans invited the Soviets to the IAAA workshop planned for Iceland the following July.

BOB KRIST

LEE BATTAGLIA

The bus that took the artists around Iceland was the only sign of human life in the island's interior.

Volcanic mountains of rhyolite near Landmannalaugar hint at the colors that might be seen on Io.

Because the Soviet delegation arrived five days after everyone else did, there were really two workshops—the first devoted to Iceland's geology, the second to cultural exchange.

Icelanders take pride in the fact that NASA's astronauts tramped across their vast lava plains and volcanic craters to rehearse their moonwalks. No bigger than Kentucky, Iceland boasts some 200 volcanoes (30 still active) and 300 geothermal areas. Workshop regular MariLynn Flynn armed her fellow site seers with a 70-page guidebook on the geological features that resemble those on other planets. The Mid-Atlantic Ridge, the suboceanic mountain range that snakes along the Atlantic's north-south axis, runs directly beneath Iceland, simultaneously tearing the landscape apart and rebuilding it anew with outpourings of lava that occur an average of every five years. In addition, because Iceland is just outside the Arctic Circle, it is strewn with dramatic deposits of ice, a material plentiful in certain outer space vistas. The largest glacier in Europe can be found here.

Nowhere are the natural forces that shape Iceland more evident than at Thingvellir, 25 miles from the capital city of Reykjavik. There the Mid-Atlantic Ridge has literally wrenched the ground open, leaving a long, broad valley between 200-foot-high scarps.

Artist Ron Miller wasn't surprised by the scenery. Like most of his American colleagues, Miller knows his science. But he was unprepared for his emotional response. "We were only in Iceland a half an hour before we all decided we were going back. If you measured the drama of the landscapes on a scale of 1 to 10, every one was beyond 10.

"At Thingvellir, you actually see two major continental plates pulling away from each other. The walls on either side of the valley move apart a few centimeters a century."

Thingvellir has both geological and mythical significance for the island's Nordic inhabitants: local chieftains held summit meetings there for a thousand years, long before the idea occurred to Reagan and Gorbachev.

"You expect to see Vikings coming around any corner," Miller says. Like almost all of the artists, Miller works in acrylics and sells most of his paintings as illustrations for magazines and books (See "Balloons Over Venus," June/July 1988). He came to Iceland not so much to paint as to record the landscape on film and to fill his head with its textures and shapes.

"We went to the ashfields at Hekla. That is the closest possible way to visit Mars on Earth," Miller says. "Have you seen the Viking lander photographs of

Kim Poor's "Saturn From Mimas" takes a different stab at "rock and ball" portrayal of planets and moons.

Leonov and studio-mate Andrei Sokolov worked together on this view of cosmonauts on the Salyut 7 mission.

LEE BATTAGLIA

Pamela Lee stands in front of one feature that betrays Iceland's terrestrial location: a waterfall. Lee likes to portray the human response to situations in space, as she does with the astronaut's awestruck stare in the painting of Mars shown above.

UOA members Leonov, Myagkov, and Poplavskiy discuss sketches of Icelandic terrain.

LEE BATTAGLIA

the Martian surface? It looks just like that.

"At Lake Myvatn we saw bubbling mud pots, hot springs, steaming vents, and sulfur deposits that made the rocks bright yellow, green, scarlet. We pretended we were on Io. It looks the same way for the same reason."

A barren, nearly unbroken tract of glaciated volcanic terrain, which stretches across the island's interior and lies atop the Mid-Atlantic Ridge, kept the artists engrossed for days. It is known as the Sprengisandur ("exploding sands"), named for the menacing popping heard under the hooves of

LEE BATTAGLIA

In one of the briefer collaborations at the workshop, Josef Minski gives Amy Hartmann a better perspective. His eerie painting at left proves that barren planetscapes are not the only scenes that express the loneliness of space travel.

LEE BATTAGLIA

When the bus got stuck in the wild, an artist scrawled on its side, "The IAAA memorial bus: Remember them."

The glaciers covering 12 percent of Iceland are visual analogs of Martian polar caps.

horses that dared cross it in times past. Today the gravel roads that cover the plain are generally passable in summer—but not always so, as the artists' unlucky driver learned.

As the group bounded across the Sprengisandur, sporadic shrieks of delight would bring the bus to a halt and send its occupants scrambling out for photographs or quick sketches. Ella Stefansdottir, the Icelandic guide, found her well-planned itinerary held hostage to the spectacular scenery. "I never realized that I've been traveling for years on Mars," she said wryly.

At Landmannalaugar, a remote riverside campsite rimmed by mountains stained red, orange, and black and topped by fields of craggy, black obsidian chunks, East finally met West. The travelers came together in a good-natured gathering of 13 artists from the United States, 11 from the Soviet Union, and one each from Canada and Great Britain.

Vodka materialized almost immediately upon the Soviets' arrival, and after the traditional bear-hug greetings, Vitaliy Myagkov, an official of the UOA, offered the opening toast to what one artist described as "our summit of international art." "We are all artists with different 'faces,' " Myagkov observed, "so we paint not for different republics

BOB KRIST

but for our individual selves."

Still, the individual styles fall clearly into two groups. Almost without exception, the Americans strive for photographic realism, whereas the Soviets favor expressionism and symbolism. In Iceland, the Soviets were less concerned with astronomy and geology than with human emotion. Some had attempted space art only rarely; others not at all. "For us, the space theme is the 'space' of human souls," observed Vyacheslav Davidov, the UOA deputy chairman.

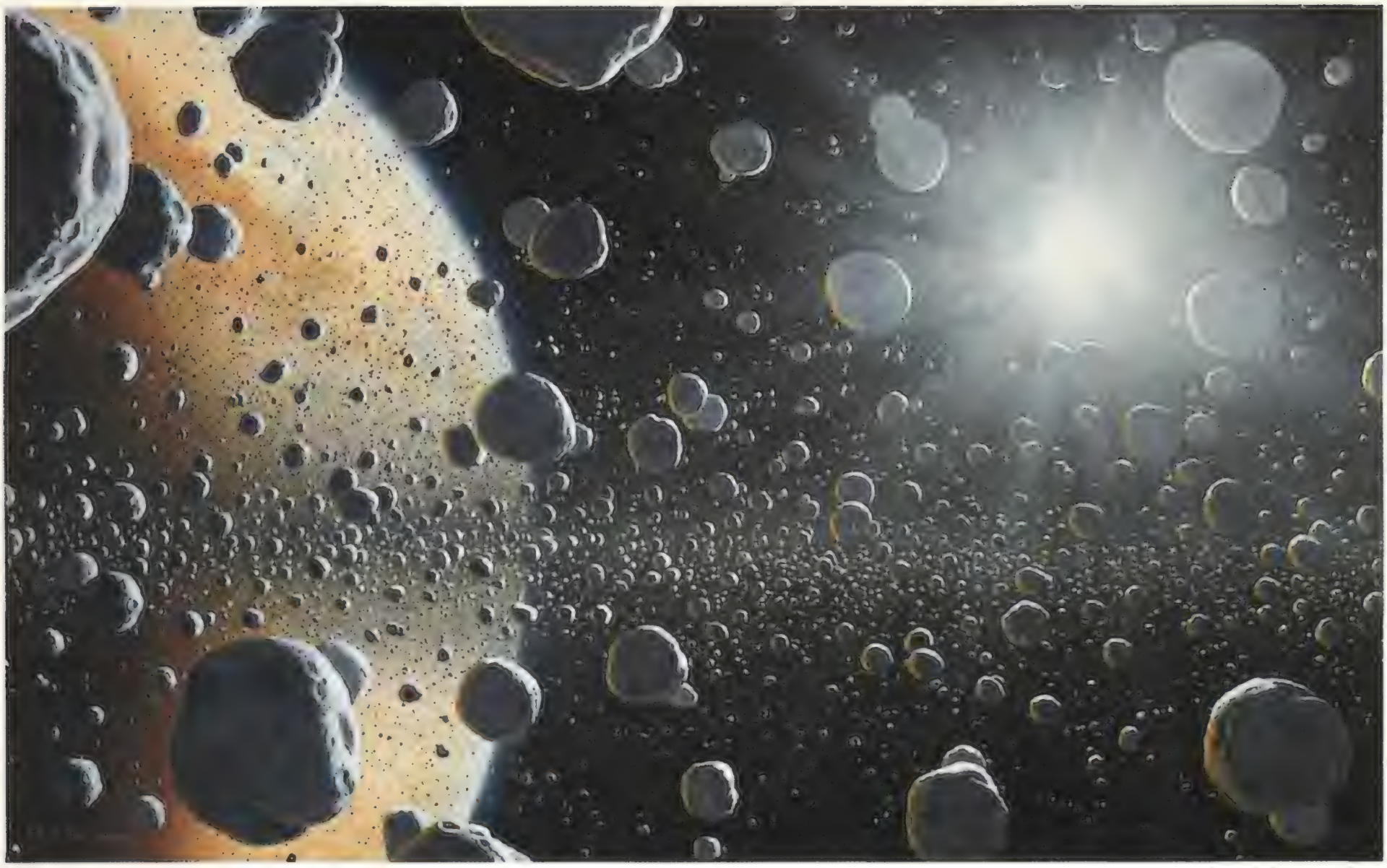
The Americans practice the genre in the tradition of the 19th century American naturalists, like those of the Hudson River school or the frontier painters who introduced the Grand Canyon and the parklands of Yosemite and Yellowstone to an amazed public. Like the earlier landscape artists, the American painters rely on careful observation and faithful reproduction.

As much as tradition, the marketplace makes realists of American painters. Many members of the IAAA would like to undertake more self-expressive projects, but the planetary landscapes that sell to Western publishers are mostly "rock and ball" portrayals, a term the artists use to poke fun at the stock composition of a planet in the background (the ball) viewed from its moon in the foreground (the rock).

Past IAAA president Kim Poor called the Iceland workshop a microcosm of the differences between the two cultures. "Russian art has a psychological focus," Poor says. "It is so different."

Aleksandr Petrov endured numbing cold long enough to record every nuance of the Baikonur launch site.

Against these odds, some of the Soviets and Americans paired off to work on projects together. The Soviet artist who seemed most in step with his Western counterparts, Aleksandr Petrov, is working with Michael Carroll on a painting of a Soyuz spaceship on its way to the Mir station. A self-proclaimed "hyper-realist," Petrov works with his wife Elena on large scenes that merge terrestrial and cosmic themes. "Nature



Voyager *photographs inspired the balls of ice in William Hartmann's painting of Saturn's rings (above).*

Peter Kovalev and his wife Olga contrast Earth today with its possible future in "Warning" (below).

LEE BATTAGLIA

Hartmann and Anatoliy Veselov confer about the problems of depicting the arrangement of galaxies.

is in total harmony," he says to explain his work. "You can't ignore any detail, whether physical or spiritual."

"Petrov specializes in launch vehicles—very realistic. So we're more compatible," says Carroll, who is currently at work on a view of Neptune's moon Triton. He is the American curator of an international exhibition of about 300 paintings that will travel through Moscow, Kiev, and Minsk this year and through the United States in

Veselov's "Cosmic Horoscope" uses the zodiac to predict the human evolution from skywatchers to spacefarers.

1990. When Carroll was in Moscow for the Space Future Forum, a Soviet scientist remarked that he hoped the realism of American art would rub off on the Soviet painters. "And I thought, gee, I hope the humanness [of their work] rubs off on me," Carroll says.

What the two cultures lacked in artistic commonality, they made up for in conviviality. Political sparring was limited and good-humored. Yuriy Orlov, an English-speaking landscape painter from Leningrad, posed behind a barbed-wire fence and urged, "Quick! Take my picture! 'Soviet artist seeks asylum!' " Togrul Narimanbekov, a highly respected talent from the Azerbaijan Republic who has been honored with the title of "People's Artist," dabbles as an

Beth Avary says the butterfly in her astrosurrealist painting "Blue Planet" symbolizes life.

operatic tenor. "When I have money, I drink," he says, "and when I don't I sing." Josef Minski, a burly artist with a Santa Claus twinkle in his eyes, delighted in teaching the Americans how to say *da*! and *nyet*! "like a man."

Language difficulties were only partially assuaged by the Soviets' two translators. As the tour bus rumbled across the island's interior, would-be conversationalists passed around the few English-Russian dictionaries aboard and thumbed through them clumsily for the basic pleasantries. At one point, workshop organizer Dennis Davidson, impressed by the work of Anatoliy Veselov, approached him about pursuing a collaboration. But no translator could be found. The pair huddled intensely for about two hours, exchanging hand gestures, written notes, blank stares, and uncomfortable silences. "Every time I'd get up to find a translator," Davidson recalls, "Anatoliy would resist with '*Nyet*! *Nyet*! Secret!' "

The Soviets wanted to strengthen relations with the IAAA not only to exchange artistic ideals but also to gain exposure to potentially lucrative Western markets. Moreover, the UOA is engaged in a turf battle back home with performance artists, and its members stand to gain politically from collaborations with Westerners.

Myagkov may have headed the Soviet delegation officially, but the spiritual leader was clearly cosmonaut Alexei Leonov, who has been painting the cosmos since 1950, long before he made the first-ever spacewalk in 1965. Leonov's English, learned 15 years ago during preparation for the Apollo-Soyuz mission, is rusty but colorful (certainly better than the Americans' Russian), full of witty patter collected over decades of life in the public spotlight. Rarely seen without his blue baseball cap, Leonov commandeered a small hotel kitchen one day to demonstrate his flair for cooking wild mushrooms. "If Leonov lived in Virginia," Virginian Ron Miller observed, "he'd be a good ol' boy." Leonov's space paintings reflect experiences gained from a privileged perspective that all the other workshop artists wished they had. "People want to know more about space," Leonov shrugs. "The most beautiful things are still on Earth."

As their six days together drew to a close, the artists found communication easier. In one last show-and-tell at a local school, they opened their notebooks and held up rough drawings like proud new parents. "That's where I found the magic starting to happen," says Hartmann. "It's too bad it happened with only one day left."

Pseudo-craters, formed when steam bursts through a hot lava flow, pockmark Lake Myvatn.

BOB KRIST

LEE BATTAGLIA

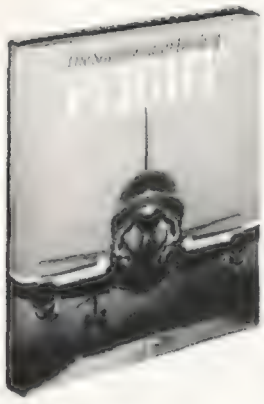
At Reykjavik the Soviets waved "dosvidaniia" *as their American colleagues departed for the airport.*

"What we weren't able to say in words we could say through our paintings," says Pamela Lee, the first American to have her paintings carried into space. Lee, whose art is more emotional than most Americans', sent color sketches of Earth to be critiqued by astronaut Bill Fisher on shuttle mission 51-I. She had heard astronauts say that although the photographs of Earth from space were beautiful, they didn't show quite what the astronauts saw. "I asked him to check them for what happens with color and light." Lee used the feedback. She is collaborating with premier Soviet space artist Andrei Sokolov, Leonov's studio-mate and the first Soviet to send paintings into space.

Somehow, enough ideas had gotten through translation intact to indicate who was interested in what, and by evening's end there were nine East-West collaborative works planned, including that of Carroll and Petrov. Davidson and Veselov will work on their "secret"; astrosurrealist Beth Avary and Narimanbekov have something in mind with "lots of symbolism."

Most of the Americans left for home the next day, but a few stayed on in Reykjavik—as did the Soviets—to explore the island a little longer. Ultimately, it fell to Leonov to offer the final toasts, walking from artist to artist with a bottle of vodka and a single glass. Then he solemnly offered each an unmistakable token of Western culture: a barbecue-flavored potato chip.

Aviation Books From Smithsonian Institution Press!



The Smithsonian Book of Flight

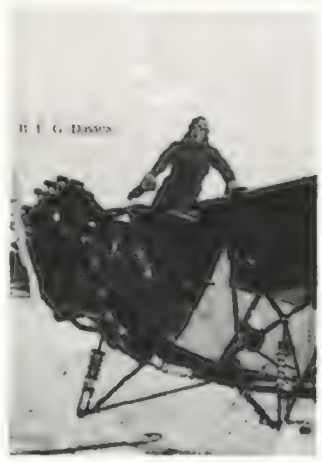
WALTER J. BOYNE
Available from *Smithsonian Books*, an imprint of the *Smithsonian Institution Press* devoted to quality illustrated books for the general reader.

200 color,
150 b&w illus.
288 pp. $26.97
(Members $22.95)
Cloth

Test Pilots

The Frontiersmen of Flight
RICHARD P. HALLION
Foreword by Michael Collins

151 b&w illus.
472 pp. $17.50
(Members $14.00)
Paper



Rebels and Reformers of the Airways

R. E. G. DAVIES
Foreword by Najeeb Halaby

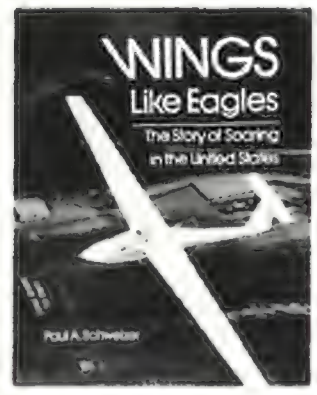
36 b&w illus., 7 maps
432 pp. $22.50
(Members $18.00)
Cloth

Contact!

The Story of the Early Birds
HENRY SERRANO VILLARD
Now Back In Print!

116 b&w illus.
260 pp. $19.95
(Members $15.96)
Paper

Special Discount for Air & Space Members!



Wings Like Eagles

The Story of Soaring in the U.S.A.
PAUL A. SCHWEIZER

200 b&w illus.
388 pp. $39.95
(Members $31.96)
Cloth

ORDER NOW!

Please send me the following books —

Quantity	ISBN	Title	20% Disc. Price	Sub-Total
	947-6H	Contact!	$15.96	
	020-2H	Smithsonian Book of Flight	$22.95	
	354-OH	Rebels and Reformers	$18.00	
	549-7P	Test Pilots	$14.00	
	828-3H	Wings Like Eagles	$31.96	
		Please add $2.25 postage & handling for the first book, $1.00 for each additional book		
		TOTAL		

A & S1

Name _____

Address _____

City _____ State _____ Zip _____

Telephone _____

Individual orders must be prepaid.
[ ] Check or money order enclosed. [ ] Mastercard [ ] Visa [ ] American Express Exp. Date _____

Card # _____ Signature _____

Associate Number _____

To order by phone, call (717) 794-2148 • Please allow 4-6 weeks for delivery

Smithsonian Institution Press

Dept. 900
Blue Ridge Summit, PA 17924-0900

AIR POWER ON ICE

"Behold ye among the heathen, and regard, and wonder marvellously: for I work a work in your days, which ye will not believe though it be told ye."—*Habakkuk 1:5*

by Noel Vietmeyer

In the summer of 1943, British and U.S. leaders convened at the stylish Château Frontenac Hotel in Quebec to plan war strategy. Debate was spirited and disagreements frequent. At the end of a particularly heated session on the morning of August 15, Lord Louis Mountbatten, Britain's Chief of Combined Operations and a member of the British Chiefs of Staff, asked permission to demonstrate a new material he claimed could help win the war.

Mountbatten ordered two handcarts rolled into the room. One carried a three-foot cube of ice, the other a similar cube of ice laced with wood pulp. He called for a strong volunteer to chop the cubes in half, and General Henry H. (Hap) Arnold, chief of staff of the U.S. Army Air Forces, stepped forward. Arnold was handed an ax. He raised it above his head, swung mightily, and easily cleaved the block of pure ice. Arnold spat on his hands, gripped the ax again, and swung confidently at the pulp-reinforced cube. The ax bounced off, leaving Arnold with a sore elbow and the ice intact. Mountbatten then took a pistol from his pocket and fired at what remained of the pure cube. The ice shattered. Next he fired at the reinforced cube. The bullet bounced off and ricocheted around the room, nicking U.S. Admiral Ernest King in the leg.

For U.S. military leaders, this was a bizarre introduction to an unusual episode in aviation history. Mountbatten and Prime Minister Winston Churchill had become convinced that reinforced ice was the stuff of better aircraft carriers. They believed "ice ships" were the answer to an increasingly intractable military problem: how to maintain the ocean-borne air power that was needed to protect vital shipping and extend the Allies' reach. Germany's naval clout was then so great that U-boats were sinking merchant ships ten times faster than they could be built, and the British navy and air force, occupied with home defense, couldn't defend them.

The idea of ice ships came from British inventor Geoffrey Pyke. In October 1942 he sent a 232-page memorandum to Mountbatten, proposing that an iceberg from the North Atlantic be leveled to provide a runway and hollowed out to shelter aircraft. Preposterous? Given the desperation of those dark years of World War II, the seriousness accorded the proposal was perhaps in proportion to the need. When Mountbatten received Pyke's plan, he summoned his chiefs and announced, "Gentlemen, I have here the means of winning the war!"

PETER ANGELO SIMON/ASSEMBLAGE BY CHRISTOPHER SELL

During World War II, Allied leaders hoped ice aircraft carriers would help turn the tide of battle.

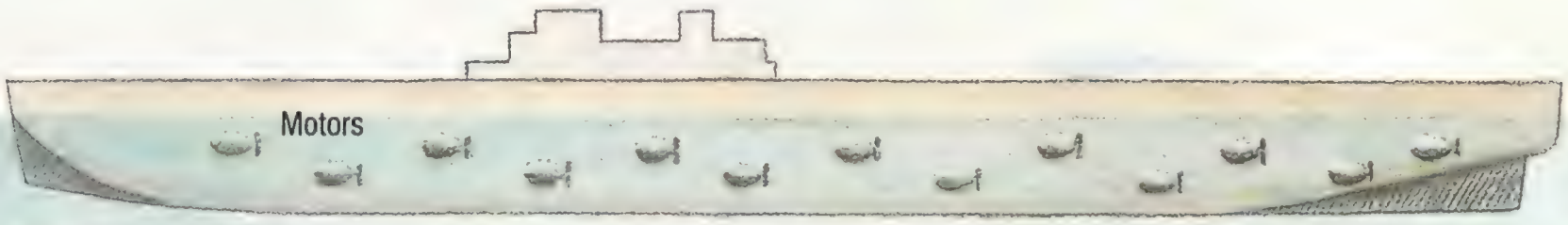
An educator, philosopher, and tinkerer who developed a military forerunner of the snowmobile, Pyke never achieved popular acclaim, never earned a university degree or honors, never produced any scientific papers. Yet physicist J.D. Bernal, Mountbatten's scientific advisor, described Pyke as "one of the greatest geniuses of his time." There were others who called him a mad scientist, and indeed he looked the part—a long face, sunken cheeks, fiery eyes, sallow complexion, and graying goatee. Still, when Pyke talked, war leaders listened.

Late in 1942, Mountbatten began a search for ice experts. Someone told him about Max Perutz, a biochemist who had studied glaciology in his native Austria. Perutz had earlier been incarcerated in a British detention camp for "enemy aliens," but within days of his release he was handed control of one of Britain's most secret war projects. He was assigned to obtain data on the strength and performance of ice. A brilliant researcher, Perutz would later excel at untangling the structure of proteins, and in 1962 he was awarded the Nobel Prize in chemistry.

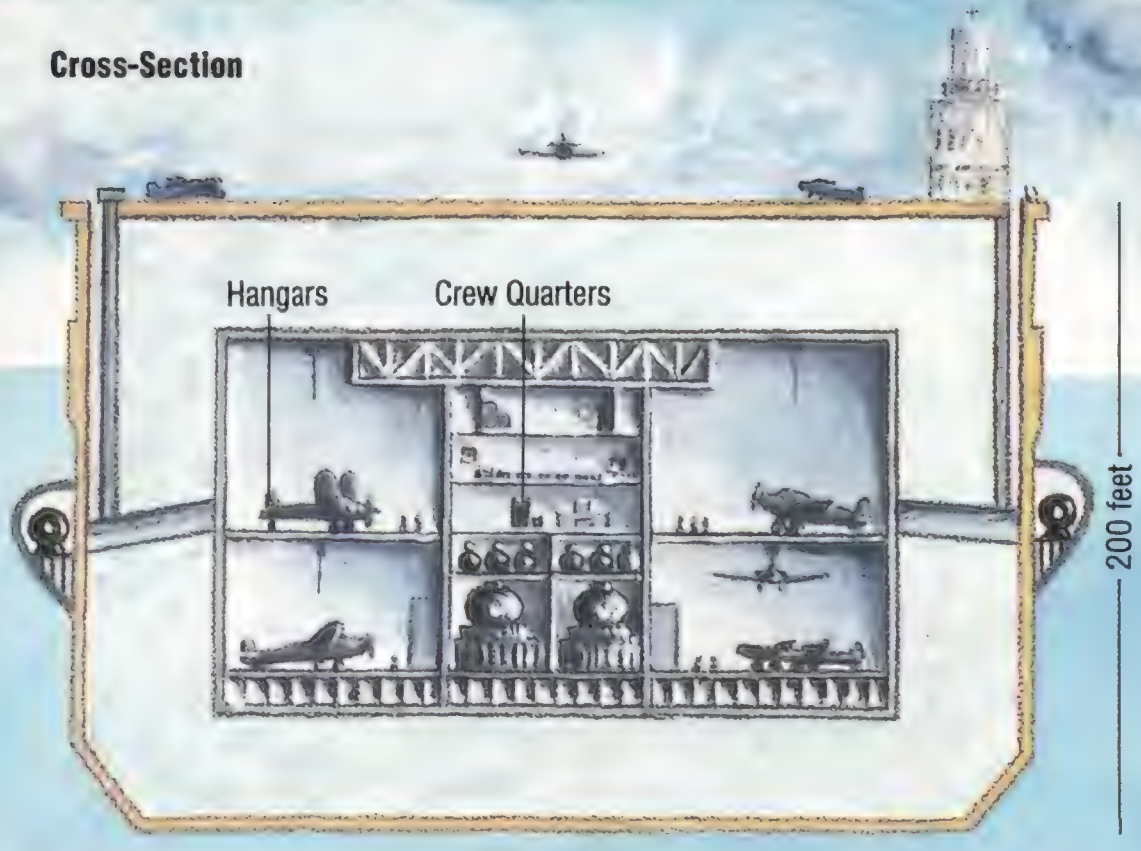
"It quickly became apparent that we could use neither icebergs nor ice floes for air bases," Perutz recalled in the *New Yorker.* "Icebergs have too little surface above the water, and even at the North Pole ice floes are only 10 feet thick, which is too thin to withstand the waves in the mid-Atlantic." Ice ships, it seemed, would have to be designed and built from scratch. Although this would be a massive undertaking, Pyke touted the plan's benefits. He pointed out that because ice floats, an aircraft carrier with a hull of ice wouldn't sink. While other construction materials—wood, concrete, and metal—were in short supply, ice could be made in abundance, and its manufacture required only one percent of the energy needed to make steel. Torpedoes, bombs, and incendiaries would have little effect, as evidenced by the resistance of icebergs to gunfire. And even if an ice ship were somehow damaged, it need not return to port: a cooling system could easily freeze more seawater for repairs.

Perutz and a small group of British engineers and physicists set to work. Their provisos were that the ice ships had to be self-propelled, fast enough to keep from drifting in the wind, and able to withstand the pounding of ocean waves. "In February 1943, the project did not look very hopeful," Perutz said, "but in March the outlook suddenly changed when I read a

The Habakkuk



Cross-Section



Top View

Specifications

Length . . . . . 2,000 feet
Width . . . . . 300 feet
Height . . . . . 200 feet
Weight . . . . . 2,000,000 tons
Material . . . . . Pykrete blocks, 10–20 feet square

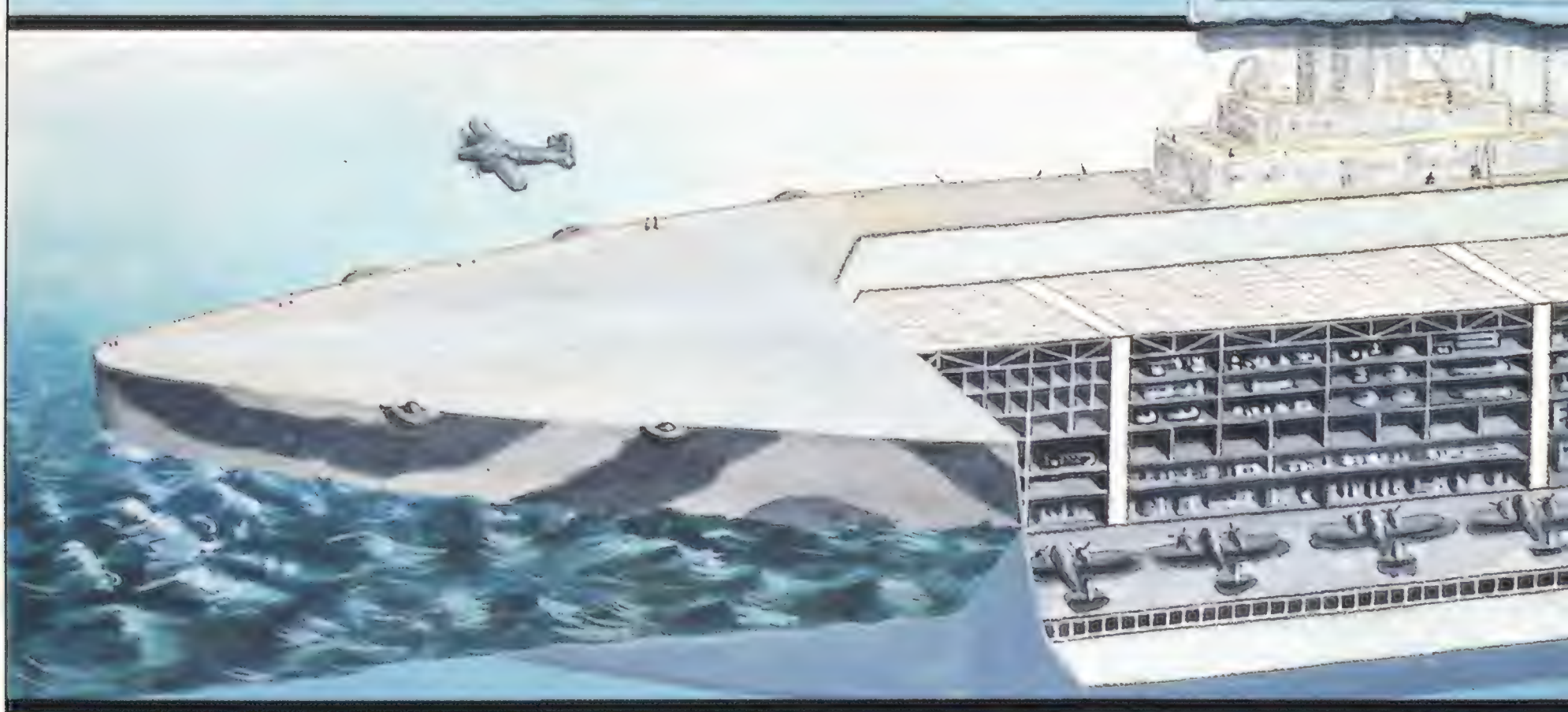
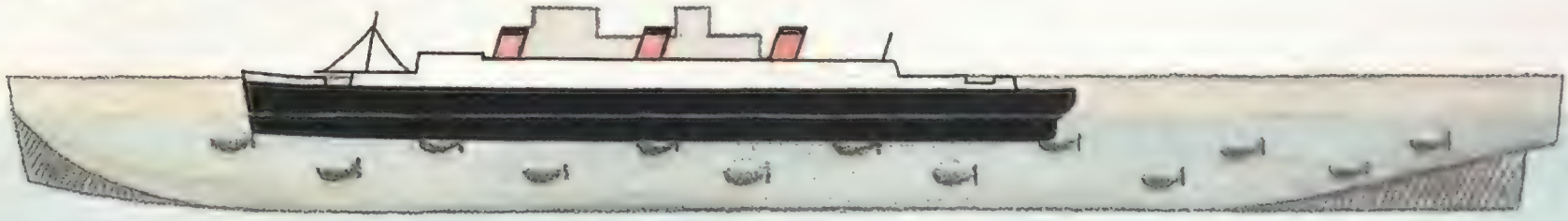


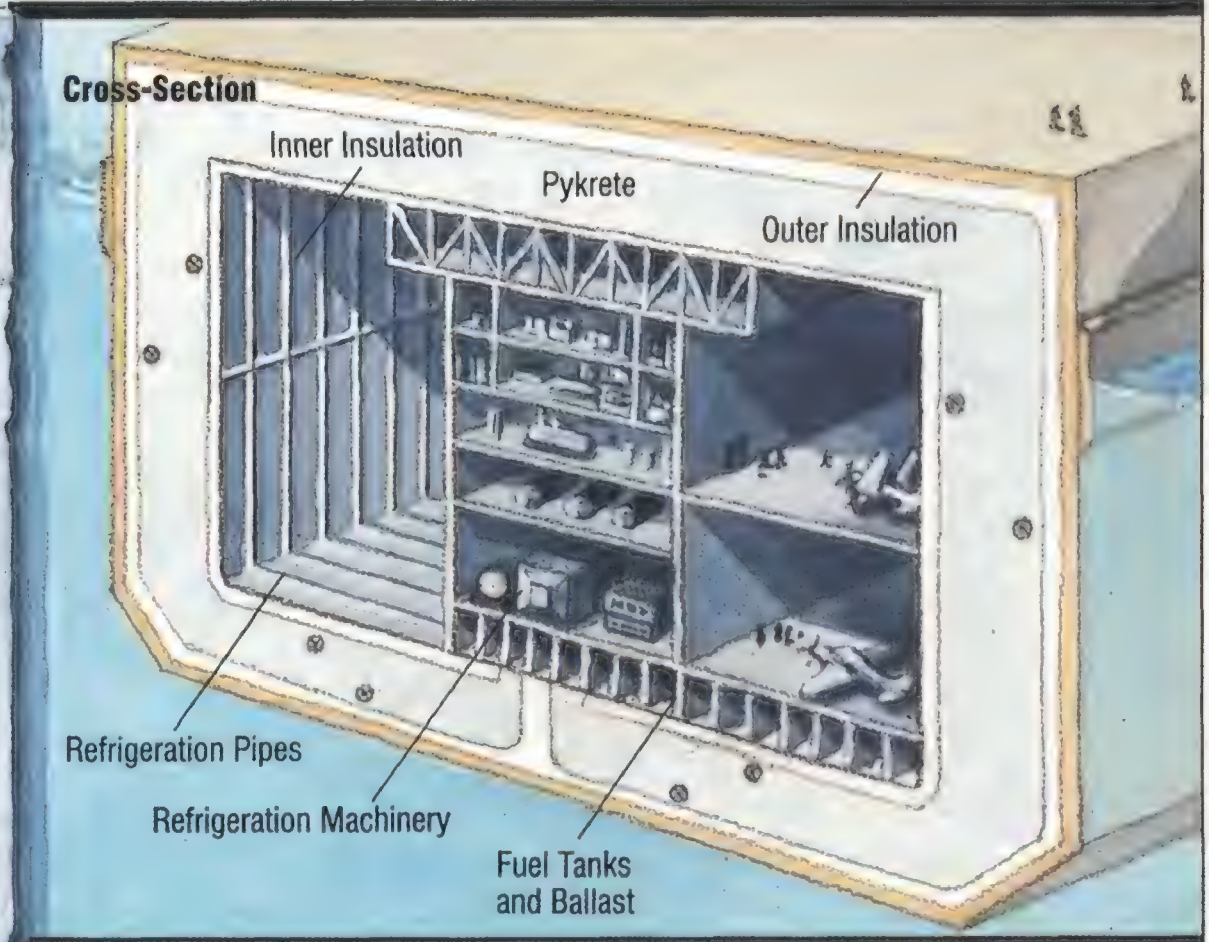
ILLUSTRATION BY TIBOR G. TOTH, ADAPTED FROM A DRAWING APPEARING IN THE BOOK *PYKE: THE UNKNOWN GENIUS* BY DAVID LAMPE, EVANS BROS., LTD., LONDON.

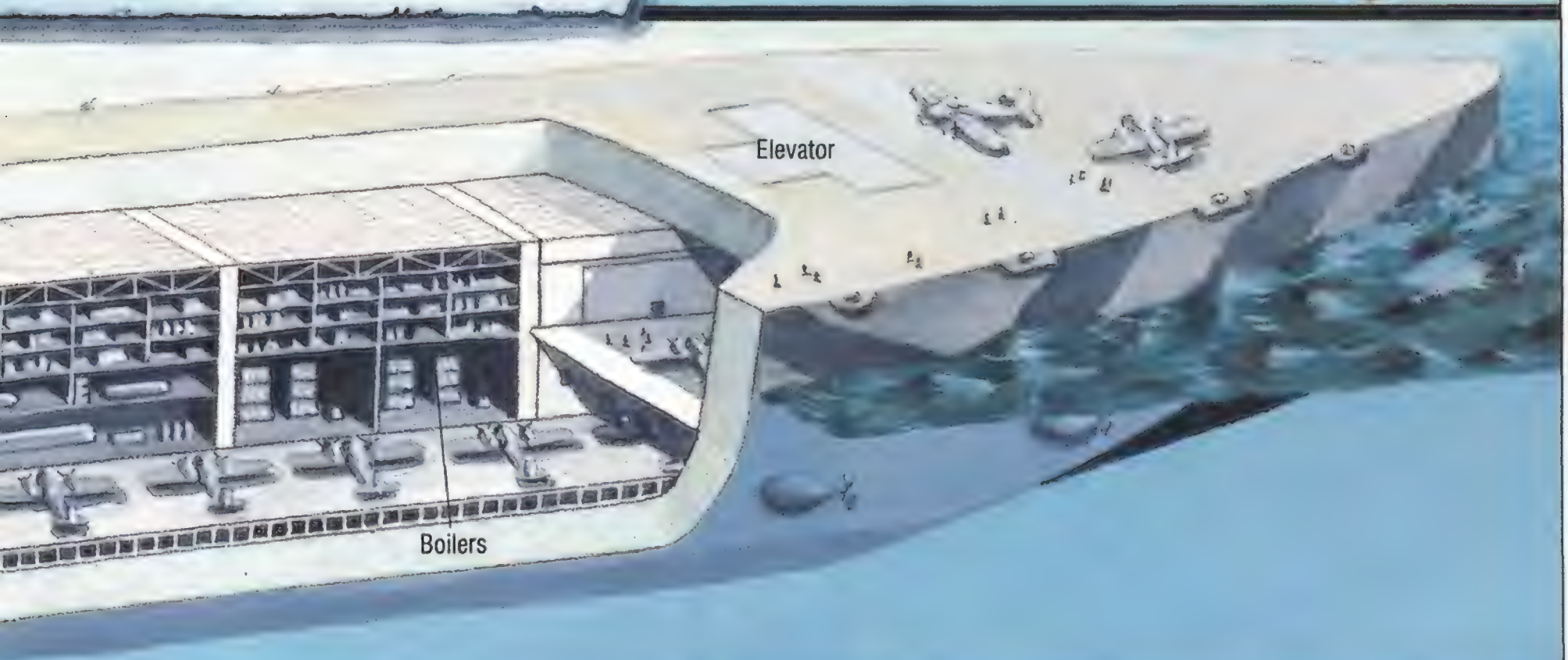
Compared With the Queen Elizabeth



Propulsion Unit

Cross-Section





ELIZABETH ANN JORDAN (2)

Geoffrey Pyke looked like a classic mad scientist. Some of the Habakkuk*'s opponents thought he was one.*

report by Herman Mark and Walter Hohenstein of the Brooklyn Polytechnic Institute in New York City. They had discovered that incorporating a small percentage of wood pulp spectacularly improved the mechanical properties of ice." In Brooklyn Poly's cold-research laboratories, Mark (a glaciologist who had been Perutz's professor in Austria) and his assistant Hohenstein stirred wood pulp—the raw material used to make newsprint—into water and froze the mixture. Mark named the new material "pykrete" in honor of the man whose far-out idea had inspired him. Reports of the amazing results soon found their way to England.

Several years after the war Mountbatten described how he demonstrated pykrete for Churchill. "I went to Chequers to see the prime minister and was told that he was in his bath. I said, 'Good, that's exactly where I want him to be.' I tipped up the stairs and called out to him, 'I have a block of a new material which I would like to put in your bath.' "

The demonstration was dramatic: the block's outer layer of ice quickly melted, but the freshly exposed pulp formed a furry coating that insulated the remainder. The prime minister was intrigued, to say the least, and the ice ship project sailed on.

Churchill ultimately decided to ask the United States to participate, which led to the tumultuous show-and-tell during the strategic planning meeting in Quebec in 1943. President Franklin D. Roosevelt, who visited the hotel a day later to meet with Churchill, was also given a demonstration of pykrete, which involved hot water instead of an ax and bullets. It was enough to persuade him to offer the services of the U.S. Navy.

In addition to Perutz, Canadian engineers and physicists had been working since January 1943 on a large-scale experiment dubbed Operation Habakkuk, after the Old Testament prophet. (In truth, a typist's error christened the project "Habbakuk.") In their universities and corporations they had worked with large slabs of ice and, later, pykrete. They even attacked them with bombs, torpedoes, and incendiaries.

In May, workers began building an experimental ice ship high in the Rocky Mountains on Patricia Lake near Jasper, Alberta. In little more than a month they constructed a 1,000-ton vessel the size of a small house—60 feet long, 30 feet wide, and with 20 feet of draft. Its exterior was sheathed with timber and the inner hull was protected by a thick insulation of pitch and vermiculite. A network of pipes circulated cold air through the hull to keep the ice frozen. The vessel had only a tiny one-horsepower engine to power the refrigeration unit, yet it stayed afloat and intact through the hot summer of 1943.

So far, so good. But making a full-sized, ocean-going ship was a more formidable task. How, for example, could a structure made of many thousands of tons of ice be kept from sagging, buckling, or breaking? Naval architects in Ottawa began tackling such problems. They produced blueprints for the *Habakkuk*, a vessel of staggering dimensions. The ice in its hull was to be 40 feet thick, and it would displace 2.2 million tons, or about 26 times as much as the *Queen Elizabeth*.

The *Habakkuk* was to be a veritable floating air base, far bigger than any aircraft carrier. Even conventional land-based aircraft would be able to use its runways. The lozenge-shaped vessel was to be almost half a mile long and as tall as a 15-story building, with vertical sides, a flat top, and a flat bottom. Refrigeration pipes would pervade the entire hull, keeping it cold no matter what the temperature. The *Habakkuk* would be suitable for use anywhere in the world—even in the tropics—and its hull would withstand waves 100 feet high.

The hull and flight deck were to be clad in timber, and between this skin and the pykrete would be several feet of insulation. The *Habakkuk* would be powered by 13 electrically driven propellers mounted in rows on either side of the hull. Inside would be the massive refrigeration units and the hangars, work areas, and living quarters—all snug and warm. It would carry 200 Spitfires and a crew of nearly 1,500.

The *Habakkuk*'s price tag, including the cost of the construction site, was estimated to be more than £17 million, or about $80 million. But what a ship. In a single voyage, it could transport from the United States enough food, raw materials, and equipment to meet Britain's needs for a year. Hundreds of merchant ships could be dispensed with, and a sizeable fraction of the Royal Navy could be relieved of convoy duty. Moreover, floating air bases such as the *Habakkuk* could be sailed into the Mediterranean for an invasion of Europe or around the Horn and into the Pacific for an attack on Japan.

Perutz and a team of engineers began planning the *Habak-*

Lord Louis Mountbatten ardently lobbied for Pyke's ice ship scheme until he was assigned to Asia.

kuk's construction. For a building site they selected Corner Brook, in Newfoundland, where local lumber mills could supply massive amounts of wood pulp. The pulp would be mixed with water and frozen into blocks in a 200-acre refrigeration plant. "The problem of launching our leviathan was to be circumvented by laying down the first pykrete blocks on wooden barges cramped together to form a large floating platform," Perutz recalled. "This would gradually sink as the mass of pykrete built up. The prototype was to be built in the winter of 1943-1944, to be followed by a fleet of 'bergships' constructed on the north Pacific coast the following winter, in time for the invasion of Japan."

The project wasn't without critics. The British Admiralty claimed that the *Habakkuk* would be too large for one captain to supervise, and that building the propulsion and steering systems would require too much steel. Furthermore, said the doubters, conventional steering wouldn't work on such a behemoth; gigantic rudders could hardly be attached to blocks of ice. Proponents countered that the ship would be steered by changing the thrust of the engines on each side of the hull, which would eliminate the need for rudders. The military was never convinced.

There were also skeptics in the United States, most notably Vannevar Bush, Roosevelt's science advisor. He was particularly upset by the way he'd learned of the idea in mid-1943. "Mountbatten and Pyke walked into my office," Bush wrote in his autobiography. "They had evidently just come from the White House. There was no presentation of a proposal, no request that the Office of Scientific Research and Development should study [the *Habakkuk*] and advise on it. Rather, Pyke told me the plan was approved and just what O.S.R.D. was now to do about it. Mountbatten looked embarrassed but not nearly enough so. Then I told Pyke, no doubt with some emphasis, that I took orders from the President of the United States and from no one else, and that ended the interview.

"As I expected," Bush continued, "it was not long before the President brought it up. He did so in the casual way in which he usually asked me about all sorts of things, and wanted to know what I thought of the idea of an ice island. I told him, 'I think it is the bunk.' He never mentioned it again."

U.S. opposition held up the *Habakkuk*'s construction. According to Perutz, "The U.S. Navy finally decided that the *Habakkuk* was a false prophet. One reason was the enormous amount of steel needed for the refrigeration plant that was to freeze the pykrete, but the crucial argument was that the rapidly increasing range of land-based aircraft was making floating islands unnecessary."

The delay ultimately proved fatal. In October 1943, Mountbatten was sent to India to command the Allied forces in Asia. Lacking his direct influence and enthusiasm, the *Habakkuk* project faltered and its priority dropped. Other factors helped sink the ice ship. By December, Portugal had offered the Azores as an air base for mid-Atlantic patrols, the main U-boat threat had been blunted, the decision to attack Europe by crossing the English Channel rather than from the Mediterranean had made a sea-going airport unnecessary, and the campaign in the Pacific against Japan was moving ahead more rapidly than anticipated. The time for giant, indestructible air bases had simply passed.

But the pykrete principle endured. The U.S. Air Force reinforced the surface of ice along a part of the coast of Greenland for use as bomber runways in the 1950s, and a Canadian company has used pykrete for structural supports in a mine on the shore of Hudson Bay. The formulation now influences the construction of oil-drilling platforms and floating runways in the frigid Arctic seas off the northern coasts of Alaska and Canada. And in 1986 *New Scientist* magazine reported the plan of Norwegian inventor Eystein Husebye to build a dock in Oslo's harbor using material similar to pykrete.

The vast collection of secret *Habakkuk* reports and papers, housed in Ottawa, remains classified. However, in 1984 the remains of the prototype ice ship were discovered 65 feet below the surface of Patricia Lake. Susan Langley, an underwater archeologist studying the project for her doctorate degree at the University of Calgary, has dived to the site several times. "Its state of preservation is incredible," she says. "All the walls are present, and the double-walled refrigeration unit is intact. It's really in remarkably good shape." The prototype's remains are the only tangible evidence of the fantastic dream that for a short while transfixed the leaders of the British war effort. ✈

If These Bags Could Speak...

Tales from the baggage handling trade

by Alan G. Ampolsk

Illustrations by Michael David Brown

Think of a modern airliner. Think of the sweep of its lines. Think of the glint of the sun on its metal and paint. Think of the sense of adventure as it banks in the afternoon light, clear of New York and bound for Rome.

Think of the suitcases in its hold that should have gone to Des Moines.

It's 10 a.m. on a fine spring Saturday at United's JFK terminal, and at the moment Helmut Patzik knows exactly where *his* suitcase is. Patzik has packed the bag—a huge affair—with 80 pounds of essentials for a trip to the Orient. With help from his wife, he's wrestling it toward the check-in counter. "Right now," he says, sweating, "I'm looking forward to getting rid of it." He pauses a moment. "I certainly hope I get it back at the other end."

According to most statistics, his chance of not meeting up with his luggage after the flight is less than one percent. "In light of the fact that [U.S. airlines are] carrying more than half a billion bags annually, if they can keep it below two percent, I think they're doing pretty well," says Daniel Smith, director of consumer and industry affairs for the International Airline Passengers Association. "But that is not to give them the impression that they don't need to continually improve it," Smith adds. "After all, these items that we're entrusting to the carrier, they're personal items. We spent time and made decisions and choices in buying them. Some of them are irreplaceable."

But when luggage is lost, who is to blame? The answer depends on whom you ask. While passengers naturally blame the airlines, airline workers say it's often the passenger's fault.

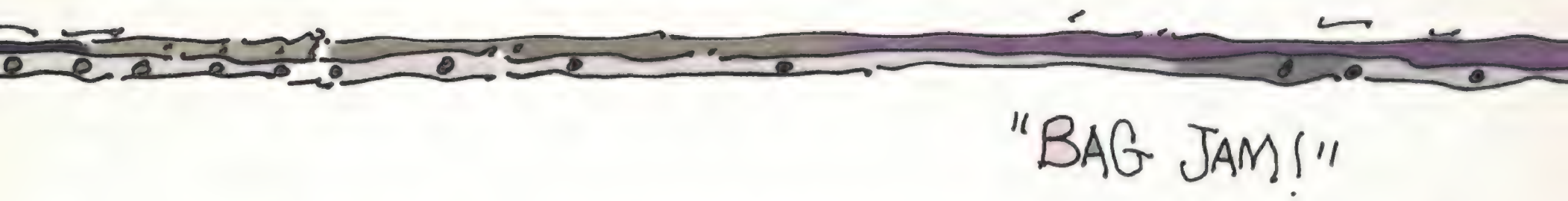
Around Mr. Patzik is a chaotic swirl of passengers for flight 801, the 11:50 a.m. Tokyo nonstop. Some are frantically packing, unpacking, and repacking in order to meet overseas weight allowances. They move toward the check-in counter in waves, carrying cardboard boxes, strollers, surfboards, and suitcases, suitcases, suitcases.

Ticket agents hoist the luggage onto a conveyor belt that runs to the outbound-bag room. Every few minutes, an agent breaks and runs for the bag room. "There's a red suitcase I tagged for Narita!" one of them shouts above the bang and clatter of luggage landing in containers. "It's supposed to be going to Seoul! The passenger gave me the wrong destination!"

"Bag jam!" yells baggage handler Jim Coogan. A massive Pacific-bound suitcase has caught between metal partitions at a turn in the conveyor belt. The belt continues to move, and two dozen bags pile up behind the stuck one. Bags spill in all directions before the belt can be shut down. It's the fourth jam of the morning. A customer service supervisor pokes her head around the door. "What's going on with you people?" she yells. "I've got a belt full and there are people lined up out the door!"

"Do you believe this?" says Pete Pisani, another handler. "They've got 20 people feeding the belt, between the clerks and the skycaps, and four of us unloading it. Twenty people feeding four guys."

The jam is cleared and the handlers



go back to sorting. Each handler is working a single flight, each of which must be sorted into three categories. Bags that get off at the destination city ("city bags") go into one group of containers; bags that transfer to other United flights ("TOBs," short for Transfer Online Bags) are placed in a second group; a third set of containers waits for bags that transfer to other airlines ("TIBs," or Transfer Interline Bags). The transfer bags are tagged for at least 10 different cities. Transfer containers will have to be broken up and re-sorted down the line. It's up to the handler to eyeball each tag and make sure the luggage goes in the right container on the right flight.

Around 10 minutes before the flight is to leave, tractors arrive and the last of the containers are towed out to the aircraft. Bags checked at the last minute are hurried out on trailers and loaded piece by piece. Sheets that list the bag count for each container are sent to the planning center; the information will be electronically forwarded to Tokyo so that the crew that off-loads the aircraft will know what to expect. Each handler has just sorted between 600 and 800 pieces of luggage.

Some 20 minutes later, just as flight 801 is starting its takeoff roll, one of the bag room crew discovers two suitcases that should have been put aboard it. They fell off the belt during the bag jam and were set aside and forgotten while the loading went on. They'll be sent out on tomorrow's Tokyo departure. A computer message will be transmitted to Tokyo. The owner of the luggage, who's probably just settling back to enjoy the flight, will find out on landing that his bags are in New York.

At 2 p.m., customer service representative Lynne Burglin takes up her post at United's lost and found. Eight flights are due to arrive on the afternoon shift. On the average, Burglin says, four passengers a day arrive to find that their bags have gone somewhere else. These people are known in the trade as Passengers Arriving Without Bags—PAWOBs for short.

Eric Stern became a PAWOB on three successive trips. Stern is a music director who works on Broadway shows. Two Novembers ago his black Samsonite valise ("it's cursed," he says) failed to make it to San Diego on a TWA flight after a stop in L.A. Inside the bag were "20 pounds of Stephen Sondheim's latest musical," the corrected copy of the score of *Into the Woods.* The show was due to make its world premiere in Southern California, and Stern needed the score for rehearsals. The bag surfaced three days later—only to disappear for two days from a Continental flight that Stern took to San Diego in December. The following March the same bag, now filled with corrected vocal parts for a recording of the musical *Rags,* failed to arrive on a direct British Airways flight from Heathrow to JFK.

"The third time I just threw a fit in Kennedy," Stern recalls. "Mothers were pulling their children away from me. I came through customs without baggage. They didn't ask me any questions, because I looked like I was going to kill them.

"Every time I fly," he continues, "I look at the people who handle the bags and I have to ask: Do the people who hire the baggage handlers also hire the people who screw the nuts and bolts on the airplane? I mean, if the guys who take care of the engine are part of the same operation . . ."

"I just think we've been given a bum rap," says Lenny Melnick, a United baggage handler. "Everyone saw that American Tourister commercial a few years ago with the gorilla jumping up and down on the bag. They think that's what goes on back here. Nobody really understands what it is we do."

What Melnick and his colleagues do isn't easy. The work is physically demanding—suitcases on long trips can weigh in at 75 pounds each, 3,500-pound baggage containers have to be pushed and man-handled onto loaders, narrow-body aircraft that aren't "containerized" have to be loaded suitcase by suitcase. Injury rates are always high. Injuries range from the chronic (back problems, knee problems caused by working in the cramped "pits" of narrow-body airplanes) to the bizarre ("We had one guy lifting up a garment bag," says Melnick, "and the hook caught another guy in the nose. Slit his nose open. Just like Jack Nicholson in *Chinatown"*) to the catastrophic (at JFK a handler was run down and killed by a tractor in Pan Am's bag room).

United's JFK station sorts all bags by hand. So do most of the world's bag handling facilities. Even at terminals that aren't exceptionally busy, manual bag sorting can be risky business. For

example, every morning at 8:15, United's flight 7 leaves for Los Angeles. Also at 8:15, flight 23 leaves for San Francisco. Although the tags for each flight are color-coded—lavender for San Francisco, orange for L.A.—that's often not much help. "The problem is, not everybody on those flights goes direct," says Al Hanson, a baggage handler who sometimes loads both flights. "Some people have bought cheaper fares. They'll go to San Francisco via Los Angeles or the other way around. The bags are tagged to the final destination. But you've got to look at the flight number also, because some of the Los Angeles bags will be going on the San Francisco flight. And if you're not paying attention, well, off it goes."

But baggage handlers will tell you that in many cases, they're not the people who are responsible for lost luggage. "We don't lose bags," says Melnick, "we only read tags. It's the skycap who puts the wrong tag on the bag, or the reservation agent who tags the bag to the wrong city."

Reservation agents will tell you that they're not responsible for lost luggage. "It's the passengers, " says Bill Bishop, a United customer service representative. "They'll tell you they're going to San Francisco when in fact they're going to Los Angeles. It's all California to them. Or they're making a connection from L.A. to San Diego but they don't tell you about it. They just say, 'I'm going to L.A.' You don't know that the bag has to go on. That's why we run through the whole itinerary with them. The idea is to catch a passenger's mistake. Sometimes you do. But sometimes the passenger has checked his luggage with the skycap at the curb. Then you've got to run and find it on the belt and retag it, if you can."

"The passenger is his own worst enemy," agrees Melnick. "Take damaged bags. Most of the time the damaged bag is caused by a passenger overloading it. Or they'll put something breakable in. You know, they put a bottle of champagne in with their tuxedo, and then they wonder what happened."

Some damage, Melnick admits, is caused by rough handling. "Do I treat your suitcases like you do? No. You've got two suitcases. I've got 600. After you load 300 of them your arms get tired and you're not that gentle anymore. But most of the problems start with the passengers."

Handlers learn to dread certain baggage. "It used to be a suitcase was a suitcase," says Hanson. "Now they've got straps, they've got wheels—stuff hanging off that jams in the belt and tears up the bag."

"Also," says Melnick, "you've got the plastic hard-sided type. People cover them with furniture polish to waterproof them. Makes them slippery as hell. You put them on the belt to load them in the plane, turn around to pick up another bag, this thing comes down and hits you in the back of the legs."

"You hate to see Ultrasuede," says customer service's Burglin. "It's always expensive, it's always that cream color, and . . . face it, it's for the back seat of a car, not for the pits of an airplane."

Sometimes the luggage isn't luggage at all. "There was an Air Florida passenger who showed up here one morning with a rowboat tied to the top of his car," says Melnick. "He wanted it checked—along with a couple of oars."

"It's amazing what they bring you," says Bishop. "Everything. Just everything. They bring artwork. They bring dishes. Not a car, but, you know, car parts . . . ."

"I've seen Christmas trees, refrigerators, sailboats, pole-vaulting poles," says Tony Careccia, Pan Am's manager of baggage systems at JFK. "I once had to refuse a St. Bernard in a six- by seven-foot kennel. It wouldn't fit."

"Washers and dryers," says Melnick. "I've seen live automobile batteries with the acid still in them. And animals—unusual animals that have broken out of their cages. You open up the aircraft and you're staring into the eyes of a snow leopard."

More than anything else, handlers complain about the weight of the bags. "It's not unusual on the Pacific flights to have a 75-pound suitcase," says Melnick. "You ever try lifting one of those things? Or all the exotic stuff in the cardboard boxes. It seems like the further people are going the more they carry."

Consumer advocates agree that passengers are to blame for certain mishaps. But they're skeptical when passengers are accused of sending their bags to the wrong destinations. "It's not the passenger's job to get the baggage from place to place," says Christopher Witkowski, executive director of Ralph Nader's Aviation Consumer Action Project. "That's what they pay the airline for." "The skycap's supposed to look at the damn ticket!" adds Daniel Smith of the International Airline Passengers Association. "If the passenger says 'Dallas' and the skycap hears 'Dulles,' then there's something wrong with the training."

Training—or the lack of it—can be a major problem. When Continental acquired People Express in 1986, it inherited "4,000 employees who had never checked baggage or given out seat numbers—they were not trained in running a full-service airline," says Continental spokesman Ned Walker. "These guys did not know the three-letter airport codes," notes Hoyte Decker, assistant director of consumer affairs for the U.S. Department of Transportation. "You might have a bag going from Rochester to Roanoke. They'd look at the "ROC" on the tag and have no idea which one it was." Walker adds, "During the first six to eight months after the People Express family joined Continental, there was a learning curve." But the new employees were all successfully brought up to par by the end of 1987.

Acquisitions can also create disruptive friction. When Texas Air acquired Eastern, it cut back staffing levels and instituted performance quotas backed

by severe discipline. With tensions between labor unions and management running high, baggage handlers struck back. "You've got three guys in the crew, and they'd want 40 percent of the incoming bags on the belt in 12 minutes," says an Eastern baggage handler at JFK who spoke on the condition that he not be named. "Nothing wrong with that, except that if you're 30 seconds over, you're suspended without pay or fired. They won't listen to excuses. If the door on the airplane was stuck for two minutes, that doesn't mean anything to them. So what the guys will do, if they see they can't make the quota, they'll rip the tags off the bags they can't unload and turn them in as lost luggage. Either that or they'll misplace them—put them in with the connecting bags, so they don't turn up till later. It's a way of making the quota so they don't lose their jobs."

"I haven't heard of that practice," says Joe Scott, an Eastern spokesman. "But if somebody's doing that, they're in violation of corporate policy."

There are also instances of handlers stealing bags. In April 1987, a Houston court convicted a baggage handler of making off with the Lone Ranger's pistols. He had stolen them from the luggage of Clayton Moore, who plays the masked man on goodwill tours. One month later, Scotland Yard undercover officers arrested 23 British Airways handlers at Heathrow Airport—known as "thiefrow" to Londoners. The handlers, observed on hidden cameras, were opening suitcases and trying on clothes before stealing them. "Anytime you're a big company you're going to have a few rotten apples," says Rod Strickland, United's former director of customer services planning.

When a piece of luggage does not reach its correct destination, the search for it begins at each airline's lost and found. (A cartoon hanging in a corner of the United lost and found at JFK shows Orville and Wilbur Wright searching for something underneath their *Flyer*. The caption reads, "Twelve minutes after their historic first flight, the Wright Brothers discovered that their luggage had been misplaced.") As United's Lynne Burglin says, "When they come in here, we know why they're upset."

Passengers are asked to describe their bags according to a chart that shows bag types. Computer inquiries are sent first to the city where the flight originated, then to other airports and other airlines. "Most bags turn up within 24 hours—usually they come in on the next flight," Burglin says. For those that don't, after an average three to five days, claims can be filed. If they aren't disputed as fraudulent, claims are usually paid within six months. The search often continues while the claim is under review.

In 1987 baggage losses appeared to be on the rise. The airlines were "trying to do much too much with too few personnel and too little training," says the Aviation Consumer Action Project's Witkowski. He and other consumer advocates point to deregulation, too-rapid mergers, tight finances, and the complications of hub-and-spoke operation as the principal causes of bag mishandling.

But 1988 brought a period of steady improvement. Complaints to the Department of Transportation's office of consumer affairs about baggage handling were dramatically down: 255 for October 1988 versus 658 for October 1987. Along with fewer mergers and the addition of some new baggage processing equipment, one reason for this turn for the better may be a set of rules put into effect in September 1987 requiring the 14 largest U.S. airlines to document their on-time arrival performance and mishandled-baggage re-

In the Land of Lost Bags

If a bag seems gone for good, there's still a chance it'll turn up—in, of all places, Scottsboro, Alabama.

Scottsboro (population 10,000) is the home of the Unclaimed Baggage Center—the world's largest dealer in unclaimed bags. Owens Company South, which runs the center, buys unclaimed bags at bulk rates from the airlines after the searches for owners have failed. It sells the contents at retail.

Owens Company South has competitors: among them, T&W's Unclaimed Baggage across the street—but is by far the largest and has contracts with "a majority of all U.S.-based airlines," says Bryan Owens, a company vice president and son of the founder. "What an airline sends us is a statistical residue," Owens says. "If they handle five million bags a year and at the end they have 5,000 unclaimed, it's really not a very high percentage."

One of the airlines that sells unclaimed baggage to the Owenses is United. "Very often, it's a situation where you've already paid the claim on the bag," according to Rod Strickland, then the airline's director of customer services planning. "This is a chance to make up a part of the loss."

Customers at the Unclaimed Baggage Center may choose from a full range of items gone astray—everything from used toothpaste tubes and underwear to jewelry and furs. But do these customers ever include airline passengers in search of lost bags? Have there been any tearful reunions?

"Never," says Owens. "Not in the 18 years we've been in business."

ports. Both have improved since then.

The biggest improvements for baggage handling will probably come with the installation of modern baggage handling equipment. "Frankly, the [present] bag handling system is not a marvel of technology," says Bill Jackman, a spokesman for the Air Transport Association, a trade group that represents U.S. carriers. "The rule has been: the more manual handling, the more bags are mishandled."

The state-of-the-art baggage handling technology is the laser reader. A more complex version of the Universal Product Code check-out devices that are sprouting at supermarkets, the reader is placed next to a conveyor belt and scans routing information from a bar-code tag. Pan Am operates a laser scan system at its JFK hub station. "It's improved our capacity tremendously," Pan Am's Tony Careccia says. "It used to be that we could handle 22 bags a minute manually. With three laser readers and high-speed conveyors, we can process 180 bags a minute." If the computer can't read a tag, says Careccia, it sends the bag to a drop-off carousel, where handlers can examine it, retag it, and send it on its way.

The system is also highly accurate. "The accuracy of the laser is 100 percent," Careccia says. "Our reliability varies from 100 percent to 92 percent, based on the amount of luggage that doesn't have the tag—baggage that comes in on commuter flights, for example, and has to be sorted by hand."

Laser scan systems aren't entirely new—Pan Am's was installed in 1984—but their deployment has until now been limited by their cost. A laser installation at Newark International last year cost Continental Airlines $20 million. United's new facility at O'Hare—"the largest and fastest bag sorting system in the world," says Strickland—cost $35 million, and American recently installed $60 million laser scan systems at O'Hare and JFK. Today, lasers are found mainly at hub stations, where the number of flights and the number of bags help to justify the price.

None of this, of course, will replace the baggage handler. "First of all, we'll be handling more flights, so we'll need more manpower," Strickland says. "And it'll always be a manual job to load the containers, or to get the bags from flight to flight on short connections." To consumer advocate Daniel Smith, this means that the tag-reading systems won't be entirely foolproof either. "It's the first major improvement I've seen since the containers came in, and it should limit the amount of interpretation that has to be done," he says. "But it won't work if somebody slaps the wrong bag code tag on the bag. Or if the tag falls off."

So what's a modern air traveler to do? Those in the know—the baggage handlers—have few tips to offer. United baggage handler Lenny Melnick sticks to carry-on bags. "If you travel often, you find there's a lot of stuff you don't have to take with you. Businessmen know that. They're our best customers," he says.

United ramp serviceman Ray Getter would probably agree with that advice. Getter often flies on vacation to Charleston, South Carolina, to visit his family. One day last year, he flew to Charleston and his bags flew to Tokyo. "They came back three weeks later," he recalls. "You could say my baggage travels. How it happened, I don't know. If it had been Shanghai, I could understand—you mix up CHS and SHA. But Tokyo?" Still, Getter says he hasn't lost confidence in his fellow baggage handlers. "Could happen to anybody. One thing, though," he adds with a grin. "You can't blame me for this one. I wasn't working that day."

"It's ALL CALIFORNIA TO THEM."

THE SWIFT REFLEXES OF EAGLES.

There are two ways to build a suspension. One way isolates you from the road. The other keeps you in touch with it. We prefer the latter. Because in order to respond to what's happening around you, you have to have a sense of it from inside, behind the wheel.

That's why we offer fully independent suspensions whenever they're appropriate. And MacPherson struts over less expensive alternatives. Plus a lot of other technological niceties that make the whole package sure-footed and athletic. That's why, from the ground up, every Eagle automobile is designed to inspire *driver confidence.*

Speaking of confidence, every Eagle Premier, Eagle Medallion, and new Eagle Summit is backed by the added confidence of Chrysler's exclusive 7-year/70,000-mile Protection Plan.*

To our way of thinking, it's the only way to fly.

7/70

For further information, call 1-800-JEEP-EAGLE.

*Protects engine and powertrain for 7 years or 70,000 miles and against outerbody rust-through for 7 years or 100,000 miles. See limited warranty at dealer. Restrictions apply.

Buckle up for safety.

Jeep Eagle

Expect the Best.

There's No Such Thing as a Risk-Free Launch

Edward Tripp
aerospace journalist
and consultant

From the beginning of the space program, our astronauts have been presented to the public as heroes, but heroes from Main Street—regular folks, just like you and me. When the shuttle came along, with its promise of cheaper flights to orbit, it got the same happy-face treatment: This will be routine, ladies and gentlemen. No sweat. Flying NASA's shuttle would be as safe as the New York-to-Boston version.

When the *Challenger* was lost, the illusion came apart, and the revelation of the actual risk to the astronauts proved to be too much for most people, including our leaders. Sometime in the future, scholars from many disciplines will study this period and wonder: What scared the people so badly? It will seem curious to historians, and it should, because in our pursuit of a risk-free society, we seem to have gotten lost along the way.

As soon as we move, life gets risky.

If we believe our own propaganda, we're approaching a state of complete self-indulgence with no trace of attendant risk. If we really believe that, it means we've lost touch with the fundamental realities of life, particularly if "life" includes moving around a little, whether by pedaling the Exercycle down at the holistic fat farm or flying to Tokyo at Mach 5. People who stand still can't live for very long. So we move, and as soon as we do, life gets risky.

If you accept risk, particularly physical risk, you've probably noticed by now that you are regarded as something of a curiosity. If you are a pilot, some of your friends will regard you with morbid fascination ("Have you ever crashed?"), and even those who'll admit to an interest will eventually demur, wrapping themselves in their higher responsibilities to the family, their jobs, or society. Pilots aren't the only ones hearing this sort of thing. Any form of striving that once made people heroes—any quest that carries with it the acceptance of risk—now makes them crazies.

By any measure, historic or otherwise, we're comfortable. And it has been the central goal of our political agenda for decades to increase the number of people who share in this comfort. We don't want it just for ourselves; we want the same level of well-being for the whole world.

To sustain that comfort, we have to be safe—safe from confrontation with other people, objects, or elements. In a comfortable world the hard edges have been padded, rounded, or smoothed—it's the home of the foam rubber lawn mower. In this world of contradictions, we have established unreasonable expectations of perfection and thereby have become the victims of our own success.

Where there is no risk, there can never be achievement. The human experience is steeped in risk and conflict, and the enterprise of flight is a good example of that. Aviation pioneers risked their fortunes and their lives, first proving they could fly and then proving that fast is never quite fast enough. They learned to fly very fast and very well and—get ready for the unreasonable expectation—soon some different kinds of pioneers came along who thought we should all fly perfectly. Today we want universal access to fast, flexible air transportation, but we make no allowance for the complex systems that such an enormous network demands. We can't seem to embrace the dynamics and variety inherent in very large air transportation networks, nor can we force ourselves to confront the elevated levels of risk that invariably accompany dynamic and

Just when you thought it was safe to go back into space . . .

varied systems. Not a week passes without a call to make air travel safer. No one can seem to say the unsayable—that there is no point at which we can ever guarantee that a given flight will be free of all risk.

Aviation has evolved into aerospace, and as the enterprise has expanded, it has created innumerable new cutting-edge technologies that tend to leap beyond the boundaries of traditional aerospace disciplines such as engineering and navigation. The tools and knowledge generated within aerospace are applied to solve other problems that affect our survival.

We made our first tentative moves into space little more than a half-century after the first sustained, powered, fully controlled flight. In that achievement alone, we have exceeded the dreams of countless generations. Still, we hesitate and debate because we are so fearful of failing. And nowhere is this more evident and more remarkable than in the United States, the nation that first held, then lost, regained, and lost again the role of guiding the human family into the sky.

Aerospace is the edge of technology; it is our nation's business, and we have been very good at it. Now it's buried somewhere down there on the list of things to do. Have we lost the will to strive and to seek? And if we have, is the change permanent or just a momentary lapse?

When John F. Kennedy asked us to put a man on the moon, he—and the nation—undertook enormous risk. Men gave their lives for that mission. But we succeeded. Had we kept going, we would already have laboratories and space stations in orbit and colonies on the moon. If we hadn't made it to Mars, we'd at least be on our way.

Krafft Ehricke was a colleague of Werner von Braun, and as a chief scientist at Rockwell International in 1968, he contributed to the success of the moon mission. He likened man on Earth to a fetus in the womb. Development proceeds to a point at which both the child and man must leave a known, comfortable environment and enter an unknown and perhaps hostile one—or die. In Ehricke's vision, the future of humanity resides not on Earth but beyond the moon. It's surprising to realize how many of us sometimes regard that as an outrageous idea. But then, so were notions that one should wander beyond a village fence or that the world is round or that we can survive speeds greater than 25 miles per hour.

We're not going to be led into the future by NASA. That's not NASA's job. The aerospace industry isn't willing to lead us, and it has trouble grappling with the basic issue, which isn't economics but a vision and the will to make that vision reality. At its highest level, during the Apollo program of the '60s, our spending on the space program reached approximately four percent of the federal budget and 0.8 percent of the gross national product. After 20 years of drifting in endless debate about whether we can afford to be in space, surely the moment is upon us to decide upon a course and stick to it. The cost of pursuing our dream is not nearly so great as the burden of striving for social equality.

When *Discovery* flew last fall, it was thrilling. And when *Atlantis* followed, we felt reassured. But immediately after both shuttles landed, people began to analyze the meaning of it all, and that's when I began to worry. They started talking about whether these successes proved the shuttle is safe. —✓

Aerospace is our nation's business, and we have been very good at it.

The Aurora Patrol

Scientists flying through wintry skies pursue the elusive northern lights.

by John W. Briggs

Photographs by Kenneth Garrett

In the Arctic, local color comes in many forms, from the down-to-Earth (above) to the out-of-this-world (right).

"Looks like dinosaurs must be frozen down there," the pilot of the Airborne Ionospheric Observatory remarked to his navigator. Five miles below the NKC-135, the rugged coastal mountains of western Greenland were bathed in faint pink twilight, the glaciated valleys shadowed in steel gray-blue. Sirius, the brightest nighttime star, was dead ahead, its magnificent, lazy scintillations of color making it look more like a colored lighthouse than a twinkling star.

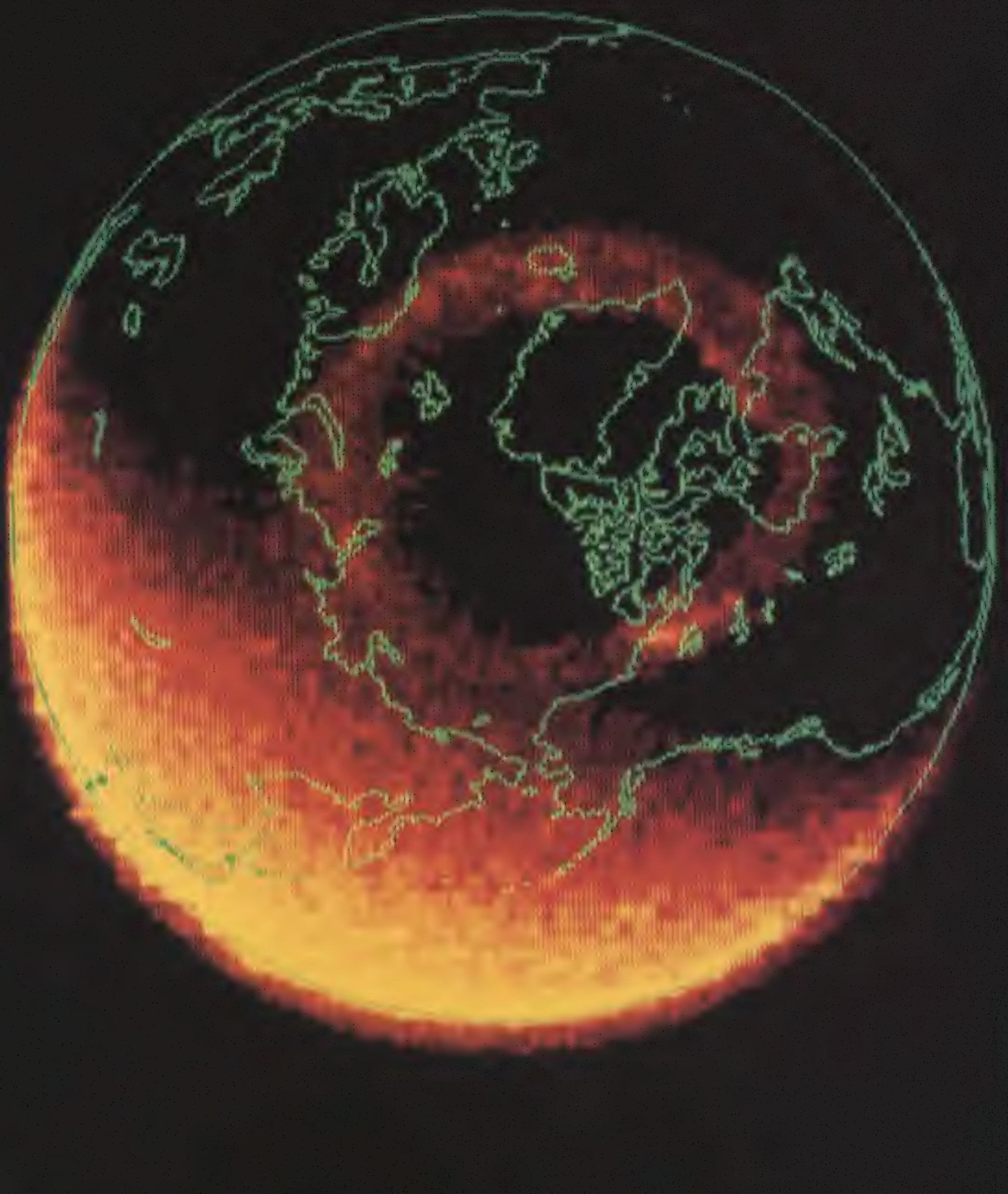
Soon, an odd milky band became visible along the horizon, passing just above Sirius and on into the remaining twilight. Only a few of us ever see these ghostly northern lights—called the aurora, after the Roman goddess of dawn—in their full splendor. Once in a great while they spill down from the Arctic and bathe the entire country in an eerie light show, with shafts of wispy light darting and undulating like folds in a wind-blown curtain.

Usually once or twice a year in the winter months the Airborne Ionospheric Observatory (AIO) embarks on a major campaign to observe and measure the aurora. The NKC-135—better known by its civilian name, Boeing 707—is operated by the 4950th Test Wing at Wright Patterson Air Force Base in Ohio for the Air Force Geophysics Laboratory at Hanscom Air Force Base in Massachusetts. Electronics dominate its interior, with a mass of cables running overhead. The host of observing instruments includes cameras and spectrometers mounted under glass domes on the fuselage, radio receivers to monitor signals from satellites, and the Digisonde, a radar apparatus that records the densities of charged particles at different altitudes within the ionosphere, the electrically conducting layers of atmosphere about 30 to 250 miles above Earth. A small group of ionospheric physicists uses the specially equipped airplane to collect data on the northern lights and other high-altitude phenomena.

In centuries past, great auroral displays were more likely to cause fright than arouse scientific curiosity. "This year dire forewarnings came over the land of the Northumbrians and miserably terrified the people; there were excessive whirlwinds and lightnings and fiery dragons were seen flying in the air," read the Anglo-Saxon Chronicles for 793 A.D. Auroral pillars were seen as battling lances, swords, and "close-ranked spears" brandished by celestial armies.

Today, we recognize that the display seen from the ground is just a small part of a much grander phenomenon. Seen from space, the Earth wears two crowns of light—the auroral ovals. The ovals are regions of intense electromagnetic activity, typically over 2,000 miles in diameter, centered near Earth's magnetic poles. Their centers seem tranquil, like the eye of a storm. But around the circumference, at an average altitude of 70 miles, bright lights dance in ever-changing patterns.

The ovals change dramatically, varying with solar activity. When Earth's magnetic field catches protons and electrons flowing from the sun—the solar wind—it speeds them toward the ovals. Once they hit the ionosphere, the solar particles collide with oxygen and nitrogen, which energize the gases. As a re-



sult, the gases glow like the discharge in a neon sign. The color of an aurora—most often a soft green—depends on the ratio of oxygen to nitrogen, which in turn depends on altitude.

While the auroras may no longer provoke fear, they do command respect. Auroral activity can cause communications blackouts and disruptions on Earth and damage to vehicles in space from electrical charging. It can also create false images on radar and expose high-altitude air- and spacecraft flying through major auroral storms to dangerous levels of radiation. One of the more practical aims of auroral research is to assemble enough data about the phenomenon to allow scientists to better predict it so that we may learn to avoid such dangers.

In February 1987, just as northern Greenland was emerging from its long Arctic night, the AIO embarked on a mission to add to that body of knowledge. The mission was part of a complex observing campaign called Project Polar ARCS (Polar Acceleration Regions and Convection Studies), centered at Sondrestrom Air Base on Greenland's west coast. The AIO would collect data from the air. On the ground scientists would use the giant Sondrestrom Incoherent Scatter Radar, a dish powerful enough to detect a dime 400 miles away, as well as direct auroral measurements from rocket-borne instruments. Polar ARCS collaborators included the Air Force, NASA, the Danish Meteorological Institute, and over a dozen universities and research organizations.

The AIO's task was to patrol the skies above the Sondrestrom radar for tenuous red auroral arcs—a newly discovered type of aurora that occurs over the polar cap, within the auroral oval's tranquil center. Because the polar cap arcs are simpler, stabler forms than those found in the auroral oval, meaningful data can be more readily collected from them. In comparison, watching the turbulent outer oval would be like trying to study the ocean's tides while a storm is blowing. But the red arcs are nearly invisible, making it difficult to accurately coordinate the launch of sounding rockets into and around them. The AIO would guide the effort by tracking the arcs with its sensitive wide-angle camera, which discovered the phenomenon during a 1979 Arctic campaign, and by maintaining radio contact with the launch control technicians at the rocket range below.

Heater carts force hot air into the AIO's engines to warm them for flight into the frigid northern skies.

Three rockets waited there. A two-stage Black Brant IX carried the sensors that would measure the electrical activity and composition of the arc. Another rocket carrying different instruments waited as an alternative; should the red arcs not materialize, it would be used to measure activity in the brighter auroral oval. The third was a Terrier-Malemute, a two-stage, solid-fuel unguided vehicle. The 34-foot-long rocket was armed with three barium shaped-charges, explosive devices designed to

The aurora over the North Pole is clearly visible in a satellite false-color image (opposite).

Transport planes bring equipment and supplies to Greenland. The AIO, a converted 707, takes over from there.

L.A. FRANK AND J.D. CRAVEN, UNIVERSITY OF IOWA

Bodo Reinisch of the University of Lowell operates the Digisonde, the AIO's ionospheric radar.

inject fast-moving clouds of barium atoms into the sunlight high above the darkened Earth. Since electrical forces as well as gravity act on the barium, any deviation from its predicted trajectory can reveal something of the action of the aurora's electrical fields.

The rockets were aimed at a predetermined location in the ionosphere above the polar cap, through which arcs were expected to move. By tracking the arcs, the AIO could notify the ground crew when to launch. But the task was a difficult one. The AIO's Digisonde can suggest if arcs are likely to form, but the phenomenon is essentially unpredictable and can move as fast as the AIO flies. Furthermore, the rocket range crew needed about three to four minutes for final countdown and launch, and the rockets required another four minutes to reach apogee, time that had to be taken into consideration when tracking the arcs' movement.

Besides spotting the launches, the aircraft would be busy recording ionospheric conditions with its array of optical and radio instruments. Without an overall picture of the aurora, the researchers couldn't interpret the measurements from the Sondrestrom radar or the rocket-borne sensors.

Weather was another factor that complicated the mission. Recording cameras and other instruments were stationed across Greenland, on the remote Arctic island Spitsbergen, and as far south as the Canary and Virgin Islands. A successful experiment required clear skies at most of these sites, and in Greenland clear skies meant the coldest weather, with temperatures often dipping to −40 degrees Fahrenheit. Heaters had to keep the rockets' sensitive payloads some 90 degrees Fahrenheit warmer than the surroundings.

On most evenings, only a one-hour interval offered the right conditions for launch. The timing depended mainly on the sun, which had to be well below the horizon for the desired darkness on the ground, but not so far that glancing sunlight couldn't illuminate the high-altitude barium clouds. Having readied the three sounding rockets, the Sondrestrom launch control crew lay in wait for word from the AIO crew to launch them. For much of the project's two-week duration that word hadn't come: the AIO, patrolling the skies, had waited in vain for the right combination.

Finally, one clear night, just as the launch window was about to close, a

When the AIO finally found perfect conditions, a sounding rocket lit up the Greenland night (opposite).

Rocket payloads are assembled in huts that provide minimal shelter from bone-numbing cold.

G. BOQUIST AND S. MUTTER FOR TECHNOLOGY INTERNATIONAL

Rocket-borne barium forms a man-made aurora. Studying its behavior helps scientists analyze the real thing.

well-structured red arc glimmered on the video screen aboard the AIO. As the arc moved within the trajectory range of the rockets, the airplane's crew sent the long-awaited signal to the ground. Within minutes the rockets thundered off, illuminating the sky with pillars of flame and smoke. As planned, clouds of barium surrounded the arc, pluming in front of, above, and beyond it. Even as the spent rocket casings crashed into icy ground, yards of paper with data from the other rocket's instruments were already spewing from recorders in a hut behind the control building. Clearly, the rocket's sensors had arched through an aurora.

Although a thorough analysis of the data would take months—it will probably not be completed until late 1989—a successful launch alone was reason for celebration. Scientists in the data room sang Danish songs, and in the shimmering, barren land, a party grew.

Join With Other Smithsonian Associates

Travel and Study, at Home and Abroad

Free Travel Newsletter
A benefit for the Smithsonian traveler, armchair or otherwise:
To learn more about actual trips, the people who take them and programs that appeal to every taste and budget, write to the address below for your free copy.

1988 RATES EXTENDED UNTIL MARCH 8, 1989
Call today to take advantage of the Washington Anytime Weekend package.

Domestic Study Tours

Sojourn in Tucson April 1-8 or 15-22: Folklore and natural history.

Savannah-Charleston April 2-9: History, homes and gardens.

Renaissance Miami April 5-10: Culture, art and architecture.

Delta Queen April 6-14: Mississippi steamboat journey from New Orleans to Memphis.

Spring Gardens April 30-May 7: From Washington, D.C. to Wilmington, Delaware.

Okefenokee May 2-7: Canoe through scenic wildlife refuge: for novice or expert.

Southwest Indians May 4-14: Hopi and Navajo from Phoenix to Sante Fe.

Brooklyn With a Bang May 25-28 or September 14-17: Architecture, art.

Sanibel-Captiva May 28-June 3: Flora and fauna on Florida's Gulf Coast.

Detroit Auto Barons June 8-11: Visit the estates of Ford, Fisher and Dodge.

Alaska Landscapes June 20-July 2 or July 25-August 6: Denali National Park and more.

Grand Canyon July 1-10: Raft down the magnificent Colorado.

Pueblo Indians July 9-16: Based in Sante Fe. Concludes with an annual arts fair.

Yosemite July 13-22: Easy naturalist-led hikes through spectacular scenery.

Salmon River July 18-26: A raft trip combining camping and a lodge visit.

Sojourn in Santa Fe July 23-30: Study historic and contemporary Hispanic culture.

Alaska Cruise August 12-23: Explore Inside Passage aboard an expedition ship.

Foreign Study Tours

People's Republic of China: Ten tours in 1989 for new and repeat travelers.

Jamaica February 26-March 8: Customs, culture, visual and performing arts.

Budapest Music Festival March 15-26: International musical performances.

Zapotec & Mayan Mexico March 2-14: Southern Mexico—culture, textiles and archeology.

Kyoto March 26-April 4: History, art and culture. Includes Nara.

Atlantic Passage April 10-26: Cruise from the Caribbean to West Africa—cultural and natural history.

Gardens of Northern Italy April 12-23: Private gardens at Lake Maggiore, Lake Orta, Verona.

Berlin April 12-26: Also features Dresden, Wittenberg, Weimar.

European Countryside Programs May-September: Relaxing sojourns in scenic and historic areas of Hungary, England, Austria, France, Italy, Switzerland, West Germany or Wales.

Botswana-Zimbabwe May 9-26: Includes Victoria Falls and Okavango Delta.

USSR-Golden Ring May 20-June 3: Study ancient Russian culture.

Danube Voyage May 23-June 9: Cruise from Rumania to West Germany aboard the *Theodor Körner*. Study the art and history of countries linked by this major waterway.

Cotswold Walks May 25-June 6: A variety of walks through the English countryside.

Central Asia May 27-June 8: From Leningrad, fly to Samarkand and Bukhara. Ends in Moscow.

Florence Seminar May 27-June 11: Classes and excursions based in a villa-hotel.

Greece May 29-June 12: History and art from Athens to Thessaloniki.

Odyssey of Flight June 2-13: Paris Air Show and 45th anniversary of D-Day.

Highlands of Scotland June 2-18: Highlands culture and natural history.

Turkey's Eastern Reaches June 7-24: East from Ankara to the ancient Orient.

Poland June 9-25: History and culture in Warsaw, Kraków and other cities.

British Isles Voyage June 16-July 3: Remote hamlets and islands aboard the *Argonaut*.

Cave Art in France and Spain June 19-July 4: Basque coastlines, the Pyrenees, Dordogne.

Swiss Countryside Walks June 21-July 6: Moderate or challenging day hikes.

Canada St. Lawrence June 22-July 3: Montreal, Quebec, Toronto as well as a cruise on the *Canadian Princess*.

Walks in England's Lake District June 29-July 12: Natural and cultural history.

Scotland by Train July 1-14: Skye, Glasgow, Edinburgh, Inverness, the Highlands.

England for Families July 10-20: Storybook London and the Cotswolds for families with children and grandchildren (ages 7-14).

Iceland July 22-August 6: Explore the island, study natural history, geology.

Baltic Passage July 28-August 12: Cruise to Denmark, Sweden, Finland, Leningrad.

Lena River/USSR July 28-August 16: Exclusive cruise through Siberia.

Voyage to Sumatra and Java August 1-17: Includes Singapore, Jakarta, Borobudur.

WRITE:
Smithsonian National Associates
1100 Jefferson Drive, SW, Dept. AS
Washington, DC 20560

OR CALL:
(202) 357-4700 for tour brochures

The Once and Future Bomber

Someday they'll retire the B-52. (Sure they will.)

by Richard Wolkomir

GEORGE HALL (2)

Squatting low-bellied on the ramp in its dark camouflage paint, the bomber looks like a winged lizard. It measures over 160 feet from its snub nose to the tail-gun stingers behind its four-story vertical fin. The swept wings

A smoky takeoff marks a B-52G's Pratt & Whitney J57s. More powerful TF33 fanjets on B-52Hs are virtually smokeless. The 30-year-old bombers lay claim to the biggest fistful o' throttles in the Air Force.

span 185 feet, longer by 65 feet than the entire distance covered by the Wrights' first powered flight. The Air Force calls it the Stratofortress. Its crews call it the BUFF—the Big Ugly Fat Fellow. It looks battered and old—and it should.

B-52s are geezers. Designed in a Dayton hotel room over a weekend in 1948, the airplane went into production as a stratospheric strategic bomber in the 1950s. It is phenomenal that the airplane still flies at all, but the Air Force plans to keep it going another 10 years—though not as a strategic nuclear bomber assigned to penetrate enemy borders. Many of the 261 B-52s in the fleet will be given the task of carrying non-nuclear weapons while 97 B-1Bs (100 were delivered; three have crashed) take on the brunt of the nuclear missions. The controversial B-1B, which has a flawed electronic countermeasures system, will be the Air Force's front-line bomber until the vaunted new B-2 Stealth bomber enters service. Until all the pieces are in place and fully operational, though, the B-52 will keep flying.

In 1956, B-52s suffered four Class A (read: "serious") mishaps in 14,860 hours of flying; that equals an accident *rate* of 27 per 100,000 flight hours, compared with a total of 15 for all other Air Force aircraft. A year later, the rate for the B-52 was down to 10. Despite its age, it has ranked consistently below the overall Class A mishap rate ever since. The improvement is due to the Air Force's intensive monitoring for cracks and other problems, as well as extensive rebuilding and updating of the bombers over the years. The B-52 has undergone 1,899 engineering modifications, making it the aeronautical equivalent of the Bionic Man.

The last of 742 B-52s came down the assembly line in June 1962; the youngest of those airplanes are now 27 years old, about twice the age of the average airliner. Age is a serious concern now that the health of the airline fleet has become a national worry after 20 feet of the upper fuselage of a 19-year-old Aloha Airlines Boeing 737 broke away in flight last April.

Metal fatigue occurs when repeated stress dislocates molecules in metal, causing cracks. The stress occurs when the metal structure flexes in response to changing loads. Pumping air into the cabin to pressurize it at high altitude causes the fuselage to expand like a balloon. And hours of flying at low altitudes can fatigue wings, which absorb the brunt of the punishment from rough air.

In the 1950s the B-52 operated in the stratosphere, where no missile or fighter could reach it. After the Soviets shot down a high-flying U-2 spyplane in May 1960, it became clear that the big bombers were now easy targets. So the B-52 adapted by descending to skim the ground, down where radar couldn't find it. Down in the turbulence.

It's no surprise that B-52s suffer chronically from cracks, popped rivets, and sheared bolts. But the airplane has earned high marks for safety since a rash of early incidents led to modifications in its structure and maintenance.

Three crashes—in Utah (1961), Maine (1963), and New Mexico (1963)—revealed that the fuselage's main rear bulkhead was too weak to endure severe turbulence. The Air Force rebuilt the bulkheads, later strengthened the upper fuselage and vertical fin, and beefed up the wings. Today's B-52s look much as the first ones did, but the

FREDERICK SUTTER/IDI (3)

Role shift: Last August, in a no-nukes exercise dubbed "Mighty Warrior 88," SAC crews practiced new missions. Ordnance crews installed drogues to slow conventional-explosive bombs after low-level release (left). Far from home bases, crew chiefs serviced B-52s with bare-bones equipment (right).

A board with the small parts labeled helped ease resupply (left).

The B-52's sole remaining strategic nuclear mission is as a "standoff" platform mounting cruise missiles (right).

G and H models—the only ones still operating today—are distant relatives of the earlier B-52A through Fs. And the differences involve much more than just structural changes.

"Never in the history of modern warfare has a major element of national defense been so long lived," wrote Walter Boyne in *Boeing B-52: A Documentary History.* The bomber owes its long career at least partly to necessity. The Strategic Air Command has kept the B-52 operating for the same reason a family hangs onto the rusty old family car: a limited budget. The B-1, which was to serve as its replacement, was canceled in favor of cruise-missile-armed B-52s by the Carter administration, then reinstated under President Reagan. That series of events helped prolong the B-52's tour of duty. But the bomber's longevity is also a credit to its designers.

As early as 1943, the Army began thinking about a replacement for the lumbering Consolidated B-36, a strategic bomber first flown in 1946 and originally designed to reach Germany from U.S. bases. Its six reciprocating engines and four turbojets could take a B-36 as far as 10,500 miles and as fast as 439 mph, but the Army Air Forces wanted something faster. Boeing's B-47, powered by six turbojets, was as fast as a fighter, but it lacked range.

At an October 1948 meeting in Dayton, Boeing presented a B-36 replacement powered not by jets but by turboprops. Soviet long-range bombers used turboprops, and turbines driving propellers were more fuel-efficient than turbojets. But the newly independent U. S. Air Force wanted more speed and higher altitude, and development of a suitable turboprop engine would take years. The Air Force told Boeing to think about a jet.

The Boeing engineers huddled over the weekend in a Dayton hotel and emerged Monday with the design for a radical new long-range, swept-wing bomber. It was big, with eight jets. Recalls William T. Hamilton, leader of Boeing's advanced bomber aerodynamics study group, "A group of us had been working on a medium-range jet bomber based on the B-47 but aiming for .8 Mach instead of .74 Mach, higher altitude, and longer range." The group at the hotel took the Hamilton team's design and scaled it up to mount eight engines instead of four, with double the gross weight and wing area and a bigger tail. On Monday, Pentagon officials gave the design the go-ahead.

"It was an out-front airplane compared to anything anyone had done at that time," says Hamilton. And the bomber's efficiency was exceptional. "It was how we distributed the weight. We spread the engines' gravitational load across the wing, so they partially compensated for the lift. Otherwise the wings would curl up." The engineers also put fuel tanks in the wings, and the weight of the fuel further counteracted the wings' tendency to bow upward. By balancing the forces acting on the wing, Boeing was able to lighten its structure.

It had become routine to design a jet with its wings swept back to delay the onset of shock waves at high subsonic speeds, but the Boeing team, borrowing from the B-47, used the 35-degree sweep angle that had proven so efficient at high speed. The engines, mounted in paired pods, were slung under the wings on pylons and located well forward of the wings' leading edges. Air flowed

GEORGE HALL

over the wings relatively undisturbed, and at high speed, the weight of the engines, cantilevered forward, acted to counteract flutter (or airflow-induced vibration that can tear a wing apart).

The B-52 is not only efficient but also highly stable—a virtue in a bomber. A B-52 from Griffiss Air Force Base in Rome, New York, recently lost three of the four spoilers that open upward out of the wings' upper surfaces and control how the airplane rolls to turn. Even without these primary flight controls, the pilot landed safely. In 1959 clear-air turbulence broke the vertical fin and rudder off another B-52. The pilot low-

GEORGE HALL

ered his aft landing wheels to create drag toward the tail and help stabilize the airplane. The crew transferred fuel to compensate for the change in weight distribution, and with exquisite delicacy, the pilot landed safely in Arkansas.

"It's really a long way from an optimum design for low-level, high-speed flight, but it's a sound structure, and it's on its third or fourth system of electronics," says former Boeing engineer William Wentz, now director of the Institute for Aviation Research at Wichita State University. "It had tremendous growth potential, a flexible design that could roll with the times," says A. T. Roper, a former Boeing engineer who now directs the Center of Technology and Policy Studies at the Rose-Hulman Institute of Technology in Terre Haute, Indiana. "It was originally for high-altitude bombing, but it was really a multipurpose design," he says. "One reason for its versatility is size—there was room to add modern electronics."

Roper compares the B-52 to a baseball team's utility infielder: "It does a lot of things pretty well," he says. "It can't do as well on any one thing as a specifically designed plane, but it can do a lot of things. And so it tends to survive longer than a specifically designed plane, which has to be at the cutting edge of its specialty. There has to be room for something extremely flexible in your arsenal." SAC tried specialty airplanes, and some were contemporaries of the B-52: the B-58 Hustler was a supersonic nuclear bomber, able to dash

A B-52H over a Mighty Warrior 88 target range stitches the southwestern sky on a practice run.

The pilot and copilot are the only crew members with a view; the other four see the world via sensors.

NASM (3)

Convair's B-58 Hustler was a Mach 2 technological tour de force, *but its cost and accident rate were too high.*

With 10 engines (four were jets), the Consolidated B-36 finally topped 400 mph, but the Air Force soon called for 550+ (left).

The Boeing B-47 was a revolution: all jet, fast as a fighter, and with lines to match. But it lacked range (right).

to and from its target at Mach 2. But there are no B-58s in service today.

During the 1960s the Soviet air defense system became so sophisticated and dense that a B-52, even at treetop level, seemed unlikely to survive an encounter with it. So the Air Force developed the Short-Range Attack Missile (SRAM), a guided rocket that was to have allowed the bomber to fight its way in by blasting ground-based radar and air defense installations as it went. A B-52 can carry six of the 14-foot missiles on a pylon under each wing and eight more on a rotary launcher mounted in the bomb bay.

But SRAMs can't defend against fighters and interceptors. In the 1970s the Soviets developed the "look-down, shoot-down" radar and other technology that enable a high-flying fighter to find and shoot at a ground-hugging B-52. The bomber's chances of evading destruction turned bleak again. "We're dreaming if we believe a B-52 can defend herself against fighters in western Europe and return," says Joachim Maître, director of Boston University's Center for Defense Journalism.

The B-52 got its only combat test in Vietnam. During an operation called Linebacker II, an all-out bomber assault on Hanoi and Haiphong, some estimates say the North Vietnamese fired as many as 1,240 missiles at the bombers. SAC lost 15 B-52s and their crews, an unexceptional attrition rate of two percent for the 729 sorties flown. But B-52 crews are not optimistic about their chances against today's air defenses. The bomber has had to undergo yet another transformation to continue in its strategic role: some B-52Hs have been modified as "standoff" platforms that would launch nuclear-armed cruise missiles while flying more than a thousand miles from an enemy's border.

The B-52 has ended up a jack of all trades and master of none. The rapid turnover in weapons systems has fogged the role of the long-range heavy bomber, which the Air Force has long insisted must be a permanent part of the strategic "triad": bombers, submarine-based missiles, and land-based missiles. The Air Force argues that bomber crews alone are capable of assessing damage from previous strikes, making on-the-spot decisions if further strikes are needed, and seeking out mobile missile launchers for destruction. The B-52 in a stand-off role can't carry out those missions. But it can perform other roles, hence the extension on its retirement date. Even the older B-52Gs will have a role: they're being reassigned to missions using conventional weapons, such as mine-laying and ocean surveillance. They could also support troops in Europe. But they won't carry nukes.

For Air Force maintenance officers, 10 more years of B-52s is a hairy challenge. The airframe is ancient, and it is crammed with three tons of various generations of electronics. At Griffiss Air Force Base, keeping B-52s healthy is a preoccupation.

"A lot of new systems use the old wiring, so you get corrosion. You've got 30-year-old wiring and it goes in strange places," says Chief Master Sergeant John Leonard, who shepherds the base's award-winning ground crews. "Structural problems come more from the change of missions," he adds. The wings "oil-can"—they flex in the low-level turbulence. "The metal gets hot, it breaks, and you get fuel leaks at the wing roots," Leonard says. His crews must constantly sniff out and seal leaks.

Although airliners fly more hours per day than B-52s do, maintenance schedules for the B-52 have to be more stringent than those for an airline operation because of the proliferation of electronics and the heavy drubbing the structure takes during training. SAC is currently stressing practice landings under such adverse conditions as engine shutdowns. "A commercial airliner may do four landings along its route, while our

B-52s log eight practice landings on one flight, and they're jiggling my spoilers, my black boxes, my everything," says Leonard. "Those wingtips can move 17 feet [vertically], and three different points on the wing can go in three different directions at the same time." Although the wing was designed for exceptional flexibility, cracks keep ground crews busy.

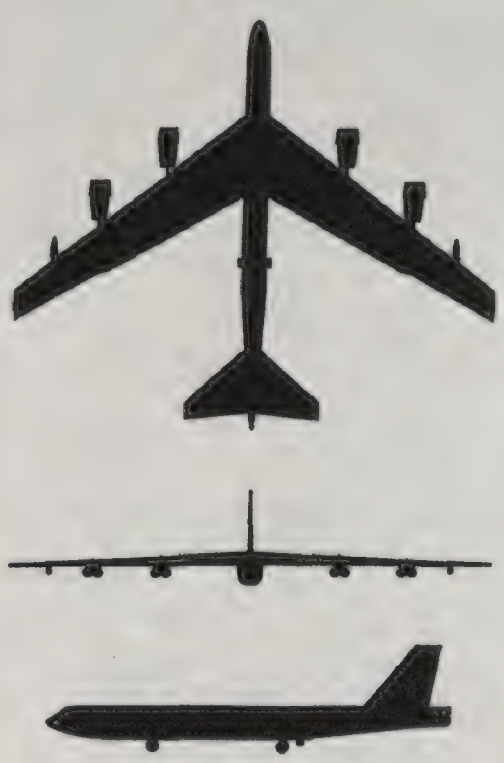
Griffiss has six bombers parked in a guarded compound, tuned up, and ready to go. The alert airplanes can take off in minutes after they're given the go signal. Colonel John Covi, deputy commander for maintenance at Griffiss, says keeping the B-52s fit requires deft juggling. The base has 19 airplanes, each of which takes a turn being grounded for three weeks as the "cannibalization" spare—it donates its parts so the others can fly. "Contractors still make parts," says Leonard, "but not necessarily new parts—they're overhauled or re-manufactured parts." And that may mean Griffiss is sometimes out of stock. "During the three weeks [when the spare plane is grounded], I may have taken 30 parts, and the cannibalization plane may have 30 holes," says Covi. Those holes have to be filled before the spare can return to the line, and some may be filled by the next airplane to act as the spare.

One bomber is always in for a scheduled check for cracks and damage, another for fuel cell maintenance. Another is grounded for training in weapons loading. One may be down for major repairs, and every four years each airplane goes to Tinker Air Force Base in Oklahoma City for a complete overhaul. At least seven B-52s are ready to fly crew training sorties and other non-alert missions.

"When Boeing first delivered these planes to the Air Force for high-straight flying, they estimated what would go wrong and when," says Covi. "Now we're flying completely differently, parts are breaking at rates we never expected, and parts are breaking that we never expected to break." That means B-52 crews bet their lives on the maintenance.

"In the four flaps on the B-52 there are maybe 2,000 rivets," says Covi. "I can look you right in the eye and tell you that once in every 200 flying hours someone will look at every one of those rivets." Leonard adds, "We've had them come in from low-level flight with virtually every one of the rivets on the spoilers gone."

Boeing B-52H



First production H model flew March 6, 1961; has same shortened vertical tail as G model; eight Pratt & Whitney TF33s with 17,000 pounds thrust each, quick-react chemical cartridge starting system on two engines; orginally designed to carry four Skybolt air-launched ballistic missiles.

For every flying hour, a B-52 receives 70.7 man-hours of maintenance, which varies with how often it flies, its mission, and the weather. Three crew chiefs working 24 hours a day in shifts oversee each bomber. They call in specialists to repair the more complex systems, such as hydraulics and radar. The bombers show their age, and aeronautical Medicare is expensive. "Each time you overhaul or re-manufacture a part, it costs more," says Leonard. "You can keep doing it as long as you're willing to throw resources at it. You could keep it up forever." But, he adds, "it gets more and more difficult every year." He says this with the faintly weary tone of a Sisyphus contemplating yet another climb up the mountain.

Maintenance officers dream B-52 dreams. Some would like to replace all eight of the old engines with four modern ones. B-52 pilots would also like that. Many are would-be fighter pilots who opted for "heavies" as a second choice. They find it embarrassing to ride an aerial steed that does not exactly charge into the sky. The J57 engines on the B-52G each generate 13,750 pounds of thrust compared with the 17,000 pounds produced by each TF33 on a B-52H. The four afterburning turbofans on the B-1B generate 30,000 pounds of thrust each. But engine replacement is likely to remain a dream.

The bomber's nose reads *Heavy Metal,* but its radio call sign for the duration of this training mission is Griff Two-One. The status book says *Heavy Metal* was built in 1958; the six crew members' average age—26.8 years—is three years younger than the bomber. Their mission today is a practice low-level bombing run over some Maine woods. It's cloudy and thunderstorms are predicted.

Captain Tom Jones leads the crew aboard through a hatch in the belly. First Lieutenant Howard Duffy, navigator, and Captain Tim Mers, radar navigator (formerly, the bombardier), sit side by side in a dark, windowless lower compartment. A ladder leads to the upper deck, where First Lieutenant Brian Hawke, electronic warfare officer, and Airman First Class Kurt Schmidt, gunner, sit facing the tail in another compartment with no windows. Only Jones and his copilot, First Lieutenant Eric Reinhard, have a view.

After an interminable roll, the B-52 lifts off. The bomber's 4,000-square-foot wings, four times the area of an average six-room house, generate enormous lift, and the bomber climbs with its fuselage horizontal, as if lifted skyward by a string. Jones levels off at 24,500 feet and 475 mph, well below the maximum altitude of 50,000 feet and top speed of 650 mph. He points to thunderheads billowing 250 miles to the west.

Four minutes from contact with a tanker, the crew members strap on parachutes as a precaution in case of collision. When they near the tanker, they also don oxygen masks in the event of a sudden loss of cabin pressure. Both Jones and Reinhard practice linking up with the tanker, but they take on only

GEORGE HALL

In the language of SAC, the word "strategic" implies "midair refueling"—day or night.

The navigators may work under nightclub lighting, but they're all business.

FREDERICK SUTTER/IDI

a token amount of fuel even though the tanks are half empty. For training, B-52s carry no more fuel than they need because, as Jones says, "it costs gas to carry gas." This B-52G weighs 164,466 pounds empty and about 525,000 pounds at its maximum inflight weight. Fully fueled, it could fly more than 7,500 miles, but given enough tankers, its range is unlimited.

The practice bombing target is in an electronic test zone, one of several located throughout the nation. Bombers simulate their attacks electronically, then ground instruments read the signals and grade the crews' accuracy. Electronic devices also simulate air defense missiles and fighter attacks, and Hawke is already picking up surface-to-air missiles (SAMs) on his screen. He can counter with the latest generation of electronic countermeasures (ECMs), designed to fool the missiles' radar. He can also shoot flares to distract infrared-seeking missiles that home in on the bombers' engines.

Griff Two-One will practice a mine-laying mission, laying five mines along a line a mile and a quarter long. Jones begins his descent. "SAMs at nine o'clock," calls Hawke as Jones levels out over the Atlantic near the coastal community of Bar Harbor.

Schmidt, seated beside Hawke, operates a cluster of four radar-controlled tail guns. In early models, he would have been seated in a lonely station in the tail, jouncing six feet for every foot the nose moved. In the G model, he gets to sit up front with the rest of the crew.

Jones drops Griff Two-One down to 3,000 feet to check the terrain avoidance system. A low-light TV camera and an infrared sensor in the nose feed images to video screens while a computer draws a jagged line called a trace across the picture, profiling the terrain. If the pilot keeps the symbol of the airplane on the screen just above the trace, he'll miss hitting the ground. Too high and he'll be vulnerable to missiles. Even in training, it's a fine line.

Jones drops to 830 feet and points to a smear on the water. "Oil spill," he says. Then he turns inland for the simulated mining runs. The bomber roller-coasters over forested hills as the crew fights 2-G climbs and abrupt descents. An amber "Bomb Doors Open" lights up on the pilots' panel, and in seconds the B-52 traverses the target, emitting electronic tones for the scorers. Tim Mers positions crosshairs on a radar screen to tell the airplane's computer its location. His system calculates a precise point in space from which the weapons are released automatically. "The real target might be invisible, like a buried missile silo, but we know that if we aim for, say, a water tower next to it, that's good enough," he explains. When all bombs are gone, the bomb bay doors are closed and the crew concentrates on running away—fast.

This is no luxury ride. Major Kenneth Pasch, a former navigator with many hours in B-52s, describes it this way: "Get in a small box. Run a vacuum cleaner for noise, turn on an electric heater, switch off the lights, and have someone shake heck out of the box."

"Get in a small box. Run a vacuum cleaner for noise, turn on a heater, switch off the lights, and have someone shake heck out of the box."

Jones sends the bomber twisting down a river valley to elude SAMs. Banking until the left wingtip seems about to touch the water, he pretends to peer into the river. "Look at the size of that trout!" he says. A logger standing beside a pickup stares up open-mouthed as the huge bomber roars overhead. "I think we made his day," says Reinhard. Then Jones pulls up hard and blood drains from the crew members' heads. "There were clouds in those hills coming up I didn't like," he explains over the intercom.

In fact, as *Heavy Metal* climbs for the flight home, black thunderheads rear up everywhere. "Okay, radar, talk to me," Jones says over the intercom. "I've got stuff to the left, stuff to the right, and stuff at 12 o'clock." Approaching Griffiss, he learns the base is shut down by an intense thunderstorm. The nearest B-52 base with decent weather is Wurtsmith, in Michigan. He climbs to 45,000 feet to save fuel, and the crew members don oxygen masks.

Last of the line: the B-52H has power, speed, and range. Its successors will have stealth.

"Any delays and we'll be on emergency fuel," he says to Reinhard. Air traffic controllers are flooded with radio calls requesting re-routings, and Jones finally declares a fuel emergency, thereby obtaining priority to land at Wurtsmith. He descends over Lake Huron and slows to 200 mph. A red panel light glows: "Main Tank Low." "I'd forgotten how sluggish this thing is at slow speeds like this," Jones mutters. The runway appears ahead.

At 7:04 p.m. Griff Two-One lands perfectly at Wurtsmith. Normally, a B-52 deploys a braking parachute to help it stop and save wear on the wheel brakes, but Jones opts to leave the chute stowed. Repacking it takes an hour, and he hopes to refuel and make it home tonight. "Hey, crew, I want you all to look good for these guys," he says over the intercom. "We're from Griffiss."

It is after 11 when Two-One finally lands at its home base. But the mission isn't over yet. At 11:35 the fliers are sitting across a table from six maintenance specialists for a debriefing. "We tried to break it but we couldn't," Jones tells the crew chiefs. Each crewman details malfunctions he noticed, but for Two-One, they're minor. Schmidt found a bolt missing from the upper cowling of his guns. Duffy was being poked in the knee by a loose cotter pin under his navigation panel. Reinhard had a slipping knob on his control panel, and Jones wrote up a faulty intercom switch.

The debriefing ends at midnight. "All that airplane needed was a colder air-conditioning system," Jones says. The crew is busy filling out postflight reports. After a ritual round of beers, they head home. It's 1 a.m., and Griff Two-One is over.

On the ramp, a crew chief starts to work off the squawk list on *Heavy Metal*. It's dark, and the bomber is just a silhouette against the lights of the base. In a few hours, it must be ready to fly again.

FREDERICK SUTTER/IDI

Get 'em Up, Scout!

An unsung hero of the Space Age, the Scout rocket has become the DC-3 of low Earth orbit.

by Joseph A. Harriss

JIM WORK/LTV

The new rocket was in trouble. In the months following its first flight, nearly half of the fledgling, four-stage Scouts had gone astray, blown up, splashed into the Atlantic, or plunged into the Pacific. The latest launch, made on September 27, 1963, had gone out of control when the third-stage steering jets stalled. The one before had flown only 32 seconds before a nozzle malfunctioned, setting off the auto-destruct charge and raining scorched rocket parts all over NASA's Wallops Island launch pad, just off the coast of Virginia.

The Scout was supposed to be a sure-fire booster with at least 90 percent reliability. But by this latest launch, 10 of its first 23 flights had ended in failure, a dismal success rate of 57 percent that had led to talk of cancellation.

"Scout was a very unhealthy program at that point," remembers Paul Goozh, at the time a young launch operations engineer at Wallops. "We were all disappointed and frustrated because we had set out to produce a first-rate launcher that would be a workhorse of NASA's space science effort."

These were the heady and nerve-racking days of the superpower space race, ignited by the Soviet Union's launching of Sputnik in 1957. As technology advanced flight from subsonic to transonic to supersonic, the possibility of achieving orbit had tantalized the engineers at NASA's Langley Research Center in Virginia. "With the age of Sputnik," says James Hall, who became the Scout operations manager, "the problem became very dramatic and very real."

The United States rapidly caught up with the Soviets. But it still lacked a medium-size, solid-fuel rocket that could be counted on to launch space probes and orbital missions economically and reliably. Engineers at Langley had conceived a small, simple launcher to fill that bill. To save time and money, it would be built largely from off-the-shelf hardware, starting with the solid-fuel motors: the Algol first stage was taken from the Navy's Polaris missile, the second-stage Castor was derived from the Army's Sergeant, and the Antares and Altair third and fourth stages were versions of the Navy Vanguard.

Hall remembers Langley as an exciting and hectic place to work during the development of the Scout. (The first four models were actually constructed and assembled there before those functions were turned over to Chance Vought Aircraft, now LTV.) A high percentage of young employees had the place resonating with enthusiasm. "This was the first space program and it was extremely intensive," Hall says. "There were 200 people working [in the pilotless-aircraft research division]. That was a lot of people. There were two shifts, lots of overtime. People got consumed with this project because it was exciting and time-driven and dramatic."

But the Scout's early troubles gave Langley's youthful enthusiasm a beating. If doctors bury their mistakes, rocket scientists send theirs up in flames, with the results landing on the evening news. "It's one of the burdens we labor under," says Goozh. "If something doesn't work right, your exposure is instantaneous and complete."

Launch schedules allow little time for tea or sympathy. "There is no time to go off and to grieve over a failure," says

Poised for a successful early launch in 1960, the young Scout was still years away from reliability.

NASA

A Rocket for All Reasons

When it comes to getting things done, the Scout has proved itself a renaissance rocket. Over the years, the Scout has boosted research in navigation, astronomy, communications, meteorology, geodesy, meteoroids, reentry materials, biology, and Earth and atmospheric sensing.

In the realm of pure science, Scout payloads have examined how aerosol contamination has affected Earth's atmosphere, mapped the planet's magnetic field, and made thermal maps of its surface. In astronomy, Scout missions have discovered new X-ray sources in the cosmos, studied quasars, and, with the series of Small Astronomy Satellites in the early 1970s, made the first observations of a black hole left by a collapsed star.

One Scout mission even checked out Einstein's gravitational and relativity theories. Gravitational Probe A, launched June 18, 1976, carried an atomic clock on a two-hour elliptical flight. When its timekeeping was compared with a super-accurate reference clock custom-built by the Smithsonian's Astrophysical Laboratory there was a minuscule difference—the probe's clock, which experienced a weaker gravitational field, sped up in relation to the clock on the ground. The test proved that Einstein was right: time *is* warped by gravity.

The Scout enabled many space scientists from other countries to get their first hands-on experience. Ken Jacobs, an old Scout hand with LTV, vividly remembers how happy the French crew members were about the December 1965 launch of their country's first satellite: "They were already pleased when we arranged to have the last 10 seconds of the countdown go *'Dix, neuf, huit* . . . .' But when the shot went off perfectly, they broke out 24 cases of champagne. It took us that night and most of the next day to do justice to it."

One thing the Scout cannot do is launch satellites into a 22,000-mile geostationary orbit. But with its three launch sites—Wallops on the Atlantic, Vandenberg on the Pacific, and the San Marco platform in the Indian Ocean—it has the unique ability to launch over three oceans. It can also inject satellites into a wider range of orbital inclinations than any other rocket.

While preparing the Mercury, Gemini, and Apollo manned flights, NASA relied on the Scout to focus on specific problems. To help determine which materials could best withstand reentry heat, the Scout launched experiments as high as 135 miles, then tilted downward and fired its third and fourth stages toward Earth so they would reach speeds of 18,000 mph through the upper atmosphere. Other missions studied how to protect spacecraft from micrometeoroids, and what to do about the troublesome radio blackout periods encountered when ionized plasma surrounds a hot reentering spacecraft.

Besides NASA, the principal customer for the Scout has been the Department of Defense, which helped formulate the initial Scout concept. It has launched targets in space so the Air Force could test anti-satellite weapons fired from F-15 fighters. And its longest running program has been the Navy's incredibly successful Transit navigation satellite. The Scout has launched 26 Transits to their 600-mile altitude (four are in operation at any given time), and they have shown reliability worthy of their launcher. The Navy recently celebrated one Transit's 21st beeping birthday.

When the Scout first launched it in the early 1960s, Transit was used only by U.S. ballistic missile submarines. In order to fire accurately—if it came to that—the subs had to know their exact longitude and latitude. But Transit's ability to give a precise fix anywhere on Earth's surface was soon appreciated by the rest of the world's ships, military and civilian. As a French naval officer explained during a press tour of France's big submarine base at Brest, "We never have any navigation problems, even remaining submerged for months at a time. We just pop up an antenna and get a fix on one of those American satellites."

Navy surveys show that more than 80,000 users worldwide have purchased the relatively inexpensive gear to receive Transit data. Besides the warships, merchantmen, and fishing boats of many nations, customers include engineers siting offshore oil platforms, surveyors drawing national boundaries, and some innovative individuals equipped to receive Transit data in their cars.

The Scout will undoubtedly continue to prove its value. Last December NASA announced that it had signed an agreement granting LTV exclusive rights to produce and market Scout for commercial uses. The agreement also gives LTV access to NASA's Scout facilities at Virginia's Wallops Island and Vandenberg Air Force Base in California.

NASA

Launched from the San Marco platform off Kenya, this vivid sphere gathered information on atmospheric physics.

NASA

An atomic clock aboard Gravitational Probe A helped prove that gravity warps time.

Goozh. "We are trying to support launch schedule requirements that are not set by the launch vehicle but by the payloads. And every one of them has a pressing reason why they want to be launched on that schedule."

The Scout's first launch—on July 1, 1960—was a precursor of the frustrations to come. "It was kind of a tragedy," says Hall. In those days, the control room was in a concrete blockhouse with a few monitoring terminals just a quarter-mile from the launch pad. "At the first stage, you could run outside and watch it take off," he says. "The noise was thunderous. The pressure beats on your chest, just like an earthquake."

To the eye, it looked like a good launch. But the radar tracking system—designed to make certain that the rocket did not endanger populated areas—detected an error of 40 degrees in the Scout's track, far outside its safe corridor. The range safety officer had to destroy the rocket.

Hall remembers the reaction in the control room. "There was a great silence," he says. "Most of the guys had been working so hard for so long. You think, *This doesn't happen. It didn't happen. It couldn't happen.* There was this stunning silence. Sure enough, it had exceeded its boundaries; we went over and looked at the plotboard. There were about 15 guys in the blockhouse. Most people just went outside and sat down and just were quiet. And some guys would cry and some guys would kick ashcans and get mad. Everybody got mad at the range safety officer. We had to restrain some of the guys. There was a lot of self-recrimination."

Hours later the explanation for the error was revealed. The launch itself had been fine (in fact, NASA lists it as a success). It was the radar tracking, set incorrectly by its operator, that was at fault. "He started a little bit off," says Hall. "It was just one of those things."

The next launch was a success. The third failed. The fourth succeeded. The fifth and sixth failed. Clearly, if the Scout were to fulfill its mandate, its handlers had to shift from hustling a new rocket into service to turning out a top-quality product. As Goozh puts it, "We had to become a lot more careful, methodical, and disciplined. This was the adolescence of the U.S. space program; we were learning that we had to be mature enough to do it right every time. The carefree days of flying by the seat of our pants were over."

JIM WORK/LTV

Now-retired chief Scout engineer Dale Fielder saw the little launcher become increasingly reliable, despite its simple technology.

To begin with, NASA imposed a three-month pause in the Scout's launch schedule following the September 1963 failure and scoured flight data for problems. Failure had never been caused by the same problem twice. One time, the hydrogen peroxide system that fed the rocket's control jets—governing pitch, roll, and yaw—overheated. Another time, carbon nozzle inserts on the first stage were deformed by the rocket's 7,000-degree heat, causing increased nozzle pressure and explosion. Still another time, an electrical short ended a launch. This very randomness was the essence of the Scout's problem.

"In those early days," says Eugene D. Schult, a retired NASA engineer who was Scout project manager at the time, "Scouts were often composed of components tested separately and then assembled in the field by different crews at different sites using different procedures. It was this lack of standardization that was killing us."

NASA engineers ordered a complete re-certification of the troubled rocket, wrote strict new quality criteria and procedures, and appointed teams of inspectors to monitor adherence. All 27 Scouts in the inventory were returned to Vought's Dallas plant, disassembled, and inspected. Electrical connectors were X-rayed, solder joints checked under microscopes, clean rooms scoured, and training stepped up.

And the Scout team kept learning. "Some Scouts self-destructed due to electrical shorts across connectors," says Lee Foster, another retired Scout project manager who was special projects engineer during the re-certification. "That taught us never to put control wires and ignition leads side by side. We also insulated the hydrogen peroxide system to keep it from overheating. And we standardized *everything*. We even ensured that all cable lengths from test equipment to the rocket were exactly the same length in the field as at the plant, so our nominals for voltage, resistance, and so on would be precisely the same."

Hydrogen peroxide tanks in the Scout's second stage were among the many parts overhauled to improve reliability. Added insulation kept them from overheating.

JIM WORK/LTV

JIM WORK/LTV

An electronic-test technician examines fins on a Scout's first stage. The fin tips work in tandem with exhaust jet vanes to provide control and guidance during liftoff.

But even the introduction of standard operating procedures, which occasionally incorporated what Hall calls "ridiculously explicit, almost insulting" detail, failed to prevent failure.

The third-stage Antares, he recalled, was designed to operate in a vacuum and thus was sealed only with a Styrofoam dust plug to keep the unit free of contamination. Detailed procedures were outlined for removing the plug and peeling back the masking tape to reveal moisture-absorbing material. There were also specifications for replacing the tape. The technician was to pierce it 12 times with a wooden pencil to permit air to escape from the rocket chamber as the vehicle ascended.

But one mechanic used a pocketknife rather than a pencil, producing slits rather than holes. As the rocket rose, the change in pressure caused the slits to re-seal. At 35,000 feet, the pressure blew up the plug—with the igniter wires inside—and the second stage failed to ignite.

Failure did not become more palatable with experience. "Each launch is like a new baby," says Hall, "and you can only be so detached."

Finally, when all the lessons were learned, the Scout's rigorous new SOPs filled seven fat volumes, and the eight-hour launch countdown covered more than 800 checklist items. "Some of the guys complained that we were getting too bureaucratic," says Goozh, "but the results speak for themselves."

Hall still feels pride in what he and other Scout engineers accomplished. "The degree of procedure standardization and configuration control we achieved is unique in the space business even today," he says. "Some Scout test equipment and procedures have been changed slightly in the last 25 years, but they're basically the same ones we designed."

The new rules may have made the Scout less fun, but they certainly made it fly. "Scout's the unsung hero of space," says Tom Perry, deputy director of NASA's astrophysics division. In December 1963 it put a scientific satellite into orbit from the Pacific Test Range at Vandenberg Air Force Base, California, the first of a long, almost monotonous string of successes: 85 out of 89 tries over the next 25 years, including the most recent launch last August 25 (see "A Rocket for All Reasons," p. 82). That 96 percent success rate makes the Scout one of the world's most reliable launchers and a key player for NASA and the Department of Defense, as well as the chosen instrument of a half-dozen other countries in their early space efforts. It also earned the steady little workhorse a spot in the National Air and Space Museum, where it stands beside other veterans of America's space program, such as the Jupiter-C, Aerobee, and Vanguard rockets.

The Scout's reliability stems not only from standardization but also, paradoxically, from its simple, even old-fashioned technology. Its heatshield and fins, for example, are insulated with cork (the Scout must endure temperatures of up to 1,200 degrees Fahrenheit as it accelerates in ascent). Its guidance system uses simple gyros that cannot be reprogrammed after launch, whereas any self-respecting rocket nowadays has flexible, computerized guidance. (The Scout's parsimonious masters considered a computerized system in the 1970s but decided it just wasn't worth the extra cost; they already had a winner.) Technicians perform checkouts with ancient oscilloscopes and other old-fangled gear that actually uses vacuum tubes. "It's 1950s technology," says Dale Fielder, who retired recently as LTV's chief Scout project engineer. "But it sure is reliable. I guess that makes us the DC-3 of space."

The Scout is one old-timer that keeps getting better. Over the years, upgraded rocket motors have more than tripled its payload. Initially it could place 131 pounds in a 300-mile orbit. Capacity has increased to 475 pounds, while space available in the bulbous heatshield enclosure on top has increased sixfold. Such improvement has made this "poor man's rocket"—a payload on the Scout costs about $10 million, compared with $45 million for the Delta and $100 million for the Titan III—one of the most versatile in the space business.

And for many countries. In addition to working for NASA and the Department of Defense, the indefatigable Scout has launched spacecraft for France, West Germany, Britain, the Netherlands, Italy, and the multi-national European Space Agency. Among the foreign users of the Scout, Italy is the most active. Indeed, it was thanks to the Scout that Italy became the third country to venture into space.

That happened on December 15, 1964, when a Scout, handled by an Italian launch team, sent up the San Marco A air density satellite. This first launch of a NASA vehicle by foreign engineers and technicians was done under the terms of a 1962 accord providing that the United States supply training, Scout rockets, and tracking, while Rome's Centro Richerche Aerospaziali furnish the crew and satellite.

NASA

With its retirement indefinitely postponed, the Scout is expected to continue onward and upward well into the 1990s—and perhaps into the next century.

The San Marco team, lead by Luigi Broglio—known in the Italian press as "our von Braun"—had the bold idea of placing the Scout launch facilities on two platforms anchored three miles off Kenya in Ngwana Bay. This gave them access to an equatorial orbit, a largely neglected area in space research. (So popular is the program in Italy that it was blessed by Pope Paul VI, who praised it as an "example of international cooperation for the progress of science.")

San Marco has successfully completed all eight of its launches. Some have benefited the United States as well. The latest one, last March, placed a U.S. science satellite in orbit, the first NASA put up after the *Challenger* accident. Italy has even bigger plans for the Scout: strapping two solid-fuel rocket boosters from Ariane onto it. This advanced Scout—known as Scout II, or, as wags have it, "Eagle Scout"—will have double the payload capacity and could be flying in the early 1990s.

Stranger proposals have been made. There was the time in 1981 when six MIT scientists suggested replacing the Scout's first-stage booster with an electromagnetic catapult. This would shoot the rocket along six miles of rails built up the western slope of a Sierra Nevada mountain, such as Mount Hood or Mount Shasta. The advantage, they argued, would be elimination of about 70 percent of the Scout's launch mass, a considerable saving. But the Electro-Scout, as this "hybrid electrochemical launcher" was dubbed, never left the realm of theory.

No matter; the Scout has survived worse. About a decade ago, NASA, deciding that the capacious space shuttle would make expendable launchers obsolete, told the Scout team to start thinking phase-out. "Theoretically, we've been getting out of business since the late 1970s, when plans for 50 shuttles a year got serious," says Jon Van Cleeve, Langley's current Scout project manager. "Everything was going to go up on the shuttle. But it hasn't quite worked out that way."

At one point, the final Scout launch was scheduled for 1983. But NASA's budget didn't keep up with the agency's plans, and the shuttle program was delayed. After the 1986 *Challenger* disaster, the old reliable Scout looked better than ever. Now NASA has decided it will need a mixed launcher fleet for the indefinite future, and will use the shuttle only when no other launchers will do.

"We're returning to smaller experiments now, thanks to increases in instrument sensitivity and miniaturization," says George Newton, former manager of advanced programs and technology in NASA's astrophysics division. "You can do a lot with small packages now, and space scientists need access to many launches rather than just the occasional big one."

NASA is counting on expendable launchers to help reduce the backlog of science missions that accumulated while the shuttle was grounded. It is budgeting $20 million for Scout-class Explorer programs in fiscal year 1989. Starting in 1991, it expects to fly two per year into the 21st century. Not glamorous perhaps, as NASA's Tom Perry points out, but not bad either.

THE AGE OF

In the 1930s a small group of designers used a fundamenta

The year is 1936. The setting is Grand Central Air Terminal in Los Angeles, where a sleek American Airlines Douglas DC-3 Flagship, its polished metal surfaces the epitome of streamlined aircraft design, prepares to take off on an overnight trip to New York. Its passengers might include Hollywood celebrities like Douglas Fairbanks Sr., Mary Pickford, Charles Chaplin, and Shirley Temple, or perhaps producer Samuel Goldwyn or A.P. Giannini, chairman of the board of Bank of America.

STEPHEN ST. JOHN

STREAMLINING

principle of airplane design to transform the look of a nation.

by Dominick Pisano

Designers believed the modern look would speed products—from hood ornaments to entire cars—into the hands of consumers.

Such passengers were typical of airline travel at the time. In the Depression-ridden era of the mid-1930s, commercial aviation was still a rather elitist mode of transport. The airlines of the United States carried more than a million passengers in 1936, but flying in one of the ultra-modern DC-3s was just a fantasy for most Americans.

However, the romantic image of the streamlined DC-3, with its distinctive hemispherical nose section, tapering cylindrical fuselage, and curvilinear all-

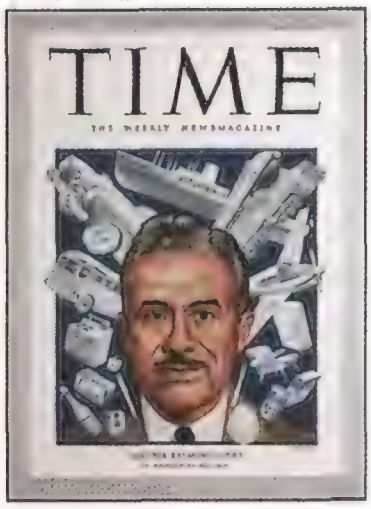
NASM

After Lindbergh crossed the Atlantic, the airplane's vistas seemed endless.

COURTESY ERIC LONG

NASM

Curvy and efficient, the Douglas DC-3 worked as transportation and inspiration.



Raymond Loewy helped create the new look that became a powerful influence on industrial design.

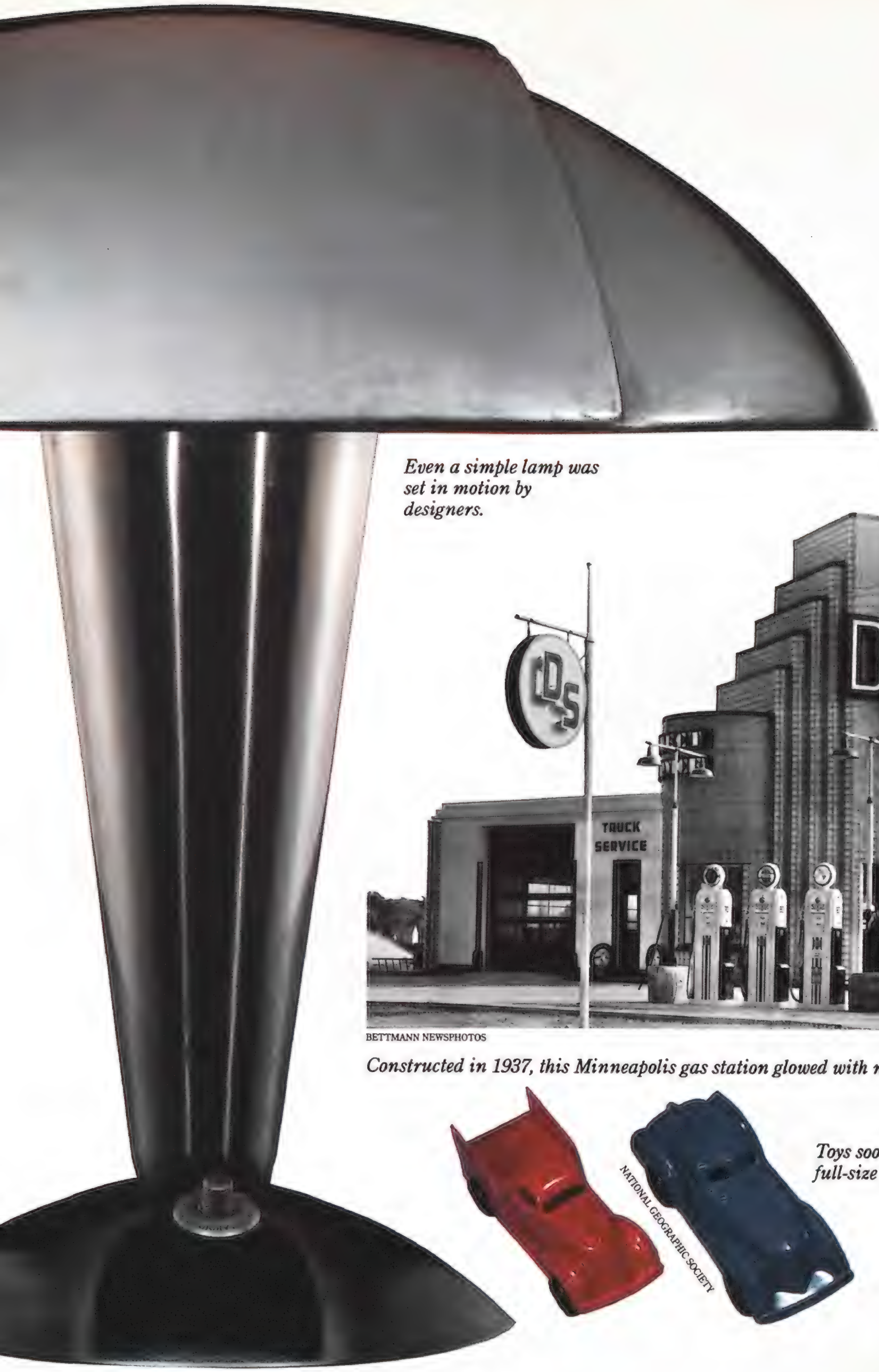
metal construction, was permeating everyday life. It was embodied in the streamlining of automobiles like the Chrysler Airflow and Lincoln Continental, railway trains like the Burlington *Zephyr* and the Union Pacific *City of Salina,* and even office buildings, service stations, theaters and diners, household appliances like toasters and vacuum cleaners, and women's apparel. The streamlined airplane had become part of the American landscape.

The relationship between the modern airplane's technological development and the social and cultural context of the 1930s made such an outcome almost inevitable. From the time of George Cayley, a 19th century British aeronautics experimenter who coined the phrase the "solid of least resistance" through air, aircraft designers had searched for a shape that would create the least drag—the resistance to a body's movement through air. The ultimate result was the Douglas DC-3, the most advanced in a line of streamlined designs that went back to the Deperdussin Racer of pre-World War I fame. The DC-3 boasted several important technological advances, but its looks also had an impact: shiny and metallic, with a pronounced parabolic curve, the DC-3 suggested speed and motion.

The dynamic design captured the imagination of a small group of U.S. industrial designers. Led by such entrepreneurs as Norman Bel Geddes, Raymond Loewy, Walter Dorwin Teague, and Henry Dreyfuss, industrial designers were applying the creative imagination of the artist to the design of mass-produced merchandise. They saw the DC-3 as the quintessential transportation vehicle, but they also wanted to take advantage of streamlining's commercial possibilities and create a new look in design. Based on their vision, the streamline movement began sweeping through American life.

Even before the development of the DC-3, however, Geddes, a poster artist and theatrical designer who became the putative head of the industrial design movement in the United States, had realized the symbolic value the airplane had for designers. In his 1932 book *Horizons,* Geddes pointed out that "when the design of an object is in keeping with the

Even a simple lamp was set in motion by designers.

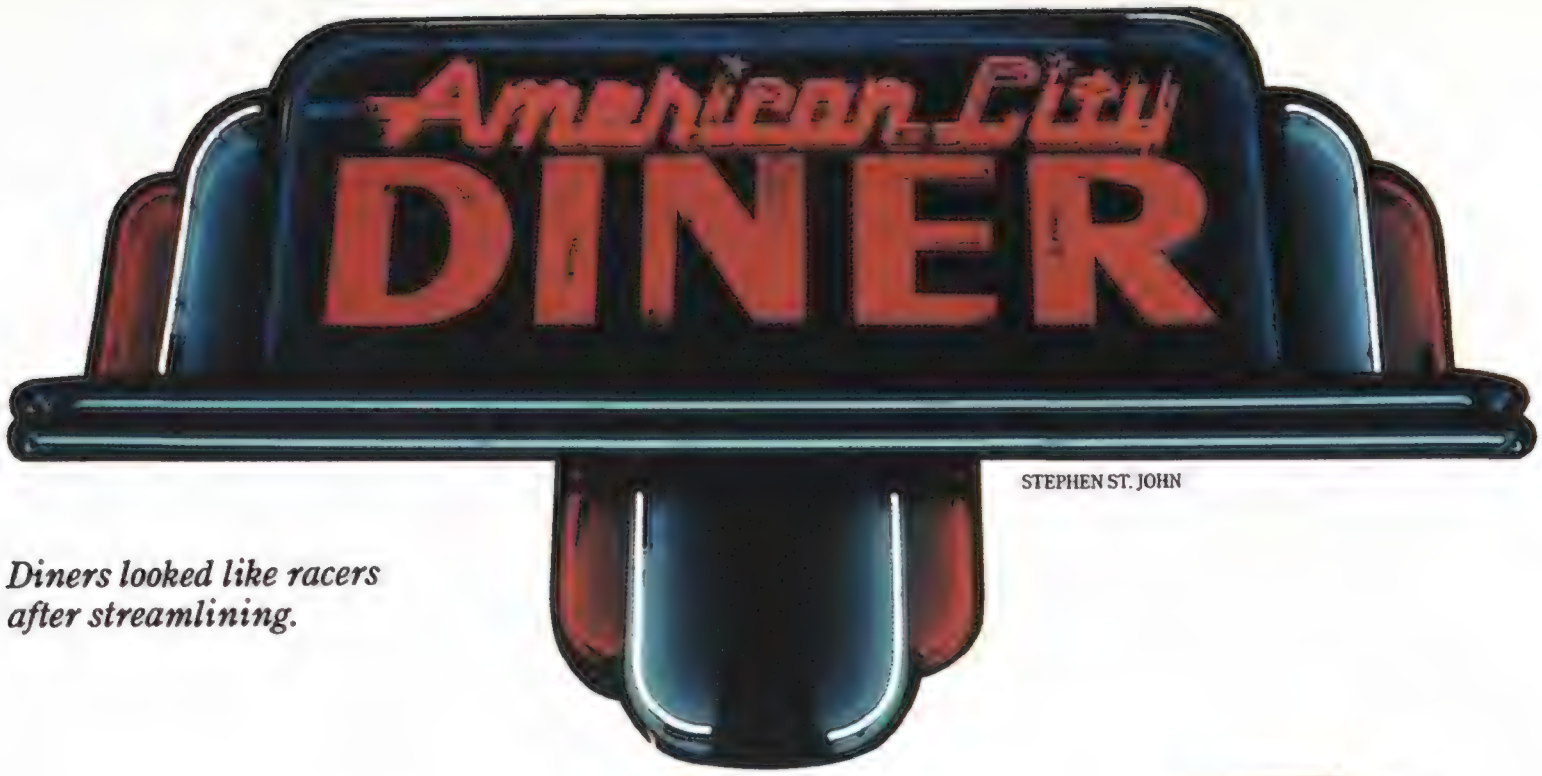


BETTMANN NEWSPHOTOS

Constructed in 1937, this Minneapolis gas station glowed with neon.

NATIONAL GEOGRAPHIC SOCIETY

Toys soon mirrored the full-size models.



STEPHEN ST. JOHN

Diners looked like racers after streamlining.

The sleek and shiny Spacelander bicycle appeared in 1948.

ERIC LONG, COURTESY JAMES HURD

Radios began appealing to the eye as well as the ear.

ERIC LONG, COURTESY NMAH

HENRY FORD MUSEUM AND GREENFIELD VILLAGE COLLECTIONS

Streamlining survived the war in the form of the Juice-O-Mat.

purpose it serves, it appeals to us as having a distinctive kind of beauty. That is why we are impressed by the stirring beauty of airplanes. The underlying principle of the emotional response that the airplane stirs in us would seem to be the same as that which accounts for the emotional effect of the finest architecture—the form, proportion, and color best suited to that object's purpose."

By 1936, Sheldon Cheney, who saw streamlining as a manifestation of Machine Age art, was singing the praises of the airplane and its look as "the most conspicuous object of the new age" in his book *Art and the Machine.* "We live in a world of streamlined vehicles," Cheney wrote. "The streamline as a scientific fact is embodied in the airplane. As an aesthetic style mark, and a symbol of twentieth-century machine age speed, precision, and efficiency, it has been borrowed from the airplane and made to compel the eye anew, with the same flash-and-gleam beauty reembodied in all travel and transportation machines intended for fast going."

And in 1940 Walter Dorwin Teague spoke of the DC-3 as an example of the pleasurable connotations of modern aircraft and cited "the constant ratios of proportion" and "the quality of line which we find most highly developed . . . in a Douglas transport plane, where you see the same type of form repeated in the engine and in the fuselage, in the wings and the tail—the same line recurring again and again; that long line with a sharp parabolic curve at the end, which we have come into the habit of calling 'streamline.' "

The streamlining movement tapped into a cultural current started by Charles Lindbergh's daring solo transatlantic flight in 1927. More than any other occurrence of the Jazz Age, Lindbergh's flight focused the attention of the world, particularly of the United States, on the airplane. To a nation transformed by World War I and the turbulent 1920s, Lindbergh's flight represented a symbolic return to values obscured by the increasing complexity of the new technological age. "Something people needed," wrote Frederick Lewis Allen in his book *Only Yesterday,* "if they were to live at peace with themselves and with the world, was missing from their lives. And all at once, Lindbergh provided it. Romance, chivalry, self dedication—here they were, embodied in a modern Galahad for a generation which had foresworn Galahads."

But the real hero of the day was Lindbergh's airplane. By taking its pilot across the dangerous Atlantic, the *Spirit of St. Louis* had reinforced in the United States the image of the airplane as a machine of progress, savior of American ideals, and symbol of a future transformed by technology. The airplane, it was reasoned, could lead the country into a technological utopia while also reclaiming past values. Its benefit for mankind seemed certain.

Two years after Lindbergh's flight, however, the country was plunged into the despair caused by economic disarray. Ironically, it was the Depression that helped make the streamlining movement so popular. Many Americans still believed in the airplane as symbolic of a better day. They had become "air minded"—conscious of the speed, motion, and potential for change that the streamlined

This jukebox was an anachronism in an increasingly unstreamlined post-war world.

BETTMANN NEWSPHOTOS

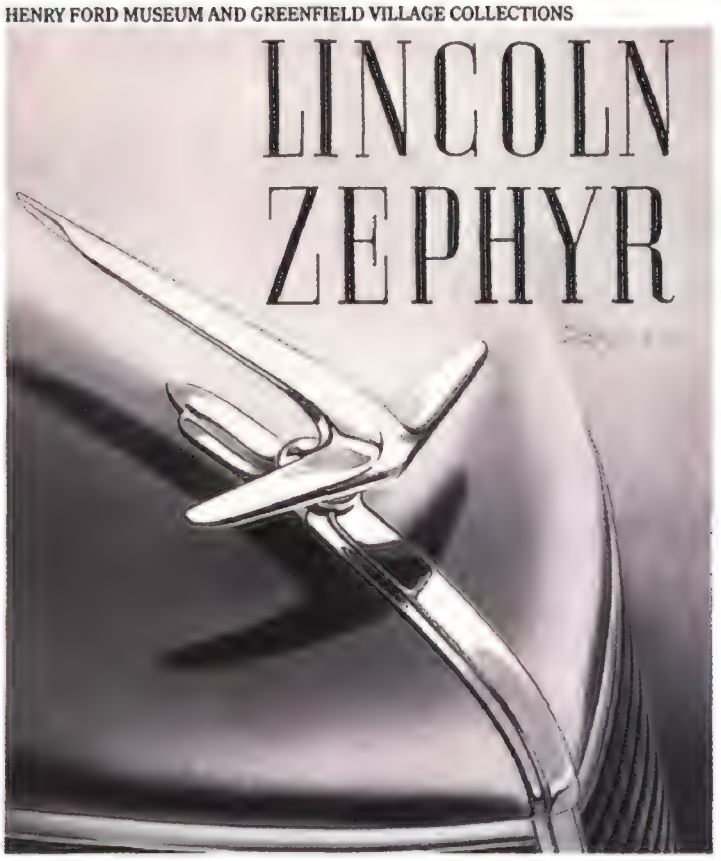
PAMELA ZILLY

Streamlining had some practical value for the aerodynamically efficient Airstream travel trailer.

airplane represented. The unstated message of streamlining was an optimistic one: technology would move the country out of the Depression and toward prosperity.

Meanwhile, the industrial designers, with the help of advertising and improved industrial processes and techniques, seized upon streamlining to sell products and promote services in an economically depressed market. As early as 1931, Abbott Kimball, a partner in the advertising firm of Lyddon, Hanford and Kimball, had prepared a brochure advising manufacturers how to "change the appearance of merchandise; the character of products; the form of containers and cartons" so that they would be more in line with the "new tempo" with its "tall angular women . . . metallic planes . . . new gamut of colors . . . strange forms and abstract figures." Kimball's pronouncements did not catch on immediately, but they set the tone for what was to come.

HENRY FORD MUSEUM AND GREENFIELD VILLAGE COLLECTIONS



The Lincoln Zephyr's graceful curves helped it succeed in the showroom.

The Pennsylvania Railroad turned to streamlined steam locomotives to combat the threat from rival streamlined trains like the Burlington *Zephyr.* The railroad commissioned Raymond Loewy to design the new machines. A native of France, Loewy, at the age of 15, had designed a model airplane, patented it, and organized a corporation and sales staff to manufacture and sell it. For the railroad, Loewy designed the striking K4S and S-1 locomotives in 1936 and 1938.

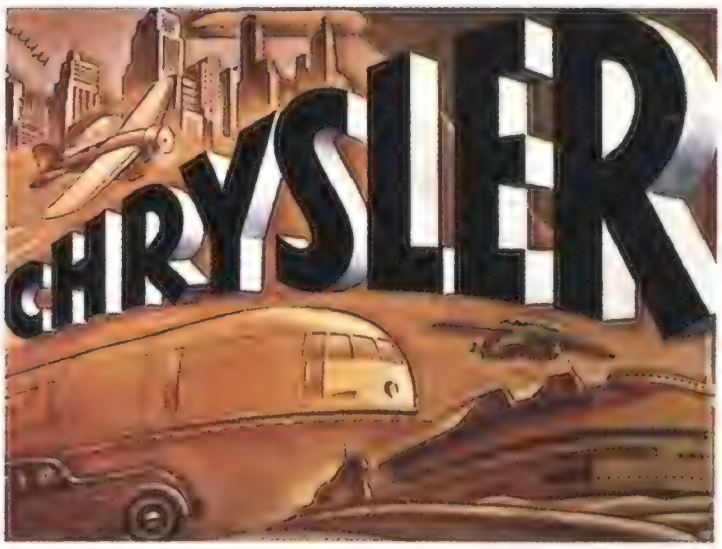
In 1934, spurred on by Geddes' *Horizons* in its search for a new product, the Chrysler Corporation produced the functionally streamlined Airflow automobile, designed by Carl Breer. The production of the Airflow incorporated aircraft design techniques and wind tunnel tests. The car sold well during 1934, but by 1937 sales had begun to lag and the car was taken off the market. The Depression had undoubtedly contributed to its demise, but Raymond Dietrich, head of exterior design at Chrysler at the time, felt that the Airflow's design didn't communicate the feeling of forward motion.

Perhaps the Airflow wasn't streamlined enough. When the Ford Motor Company followed in the Airflow's footsteps, it was with

BEHRING MUSEUM

The 1933 Pierce Silver Arrow hinted at the look to come.

BEHRING MUSEUM



Chrysler's Airflow proved a disappointment, but other automobiles followed its design lead.

HENRY FORD MUSEUM AND GREENFIELD VILLAGE COLLECTIONS

Manufacturers claimed that streamlined packaging would increase sales.

MUSEUM OF SCIENCE AND INDUSTRY

Passengers enjoyed modern trains like the Burlington Zephyr.

HENRY FORD MUSEUM AND GREENFIELD VILLAGE COLLECTIONS

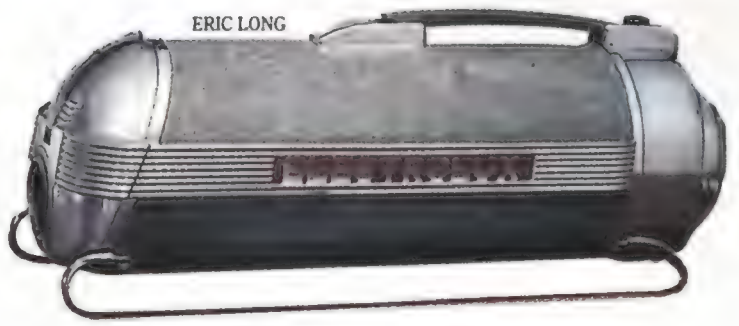
A Christmas card from a Michigan utility depicted the hoped-for streamlined world.

ERIC LONG

New materials and designs brought the kitchen into the future.

BETTMANN NEWSPHOTOS

An air-minded diner served customers in Los Angeles.



ERIC LONG

Were consumers impressed by a streamlined vacuum cleaner?

the more gracefully streamlined Lincoln Zephyr, which appeared in 1936. Buyers who hadn't been much interested in the technical claims made for the Airflow proved more attracted to the appearance of streamlining in the Zephyr and in other streamlined automobiles, like the 1936-37 Cord 810/812, designed by Gordon Buehrig, and the 1940-41 Lincoln Continental, conceived by Edsel Ford and designed by Bob Gregorie.

At the same time it was coming to dominate the design of surface transport vehicles, the streamline style was surfacing in a host of static objects. By the middle to late 1930s, streamlining had been incorporated into a number of common household items, including refrigerators and electric fans. The designers of these products did not duplicate the DC-3's appearance, but they did employ the metaphor of streamlining with speed lines—three parallel lines in metal to connote motion; rounded corners; teardrop shapes; new materials—polished metal alloys, bakelite, vitriolite, and glass block; and metal stamping and casting processes. According to *Fortune* magazine, redesigns of prosaic items such as toasters, check registers, and stoves would involve costly retooling, but increased appeal and decreased production costs passed on to consumers could conceivably increase sales from 25 to 900 percent.

By the end of the decade, the streamlining influence had spread to commercial and popular architecture. In addition to Walter Dorwin Teague's sleek, white porcelain enamel service station design for Texaco in 1936, the style was especially popular in the design of the urban and roadside diner, with its stainless steel skin, horizontal bands of porcelain enamel, rounded corners, and curved window ends. Although some streamlined diners and commercial structures like the Austin Company's NBC building in Los Angeles, completed in 1938, and Frank Lloyd Wright's elegant Johnson Wax Building in Racine, Wisconsin, finished the following year, are still standing, most of those constructed in streamlining's heyday have been leveled by the wrecker's ball.

The fate of the streamlining movement and what it symbolized is perhaps best represented by the disassembly of the 1939 New York World's Fair at Flushing Meadows, the showplace and culmination of the streamline style in American culture. Among the fair's many streamlined buildings was Futurama, the General Motors Pavilion designed by Albert Kahn Associates and Geddes. Here, a visitor

JOHNSON WAX

Frank Lloyd Wright's Johnson Wax Building still looks futuristic today.

could board a rubber-tired train and embark on a 15-minute simulated airplane flight westward over a vast futuristic diorama of America in the year 1960. This was a streamlined country of 14-lane superhighways divided into 50-, 75-, and 100-mph traffic lanes with a metropolis dominated by streamlined skyscrapers.

The fair's prospect of a better future through technological progress didn't materialize. Already the threat of World War II hung over Flushing Meadows. Europe was preparing for war, and the image of the polished streamlined airplane began to give way to visions of a machine with an unmatched potential for destruction.

Lindbergh put it best. In a 1954 speech to the Institute of Aeronautical Sciences, he eloquently summarized the failed optimism attached to the role of the airplane in modern society. "When the airplane was very young," he said, "most of us thought that men on wings would soar over mountains and oceans to bring countries close together in peaceful understanding . . . . With hindsight we see that our early enthusiasm . . . blinded us to natural laws which govern the basic conduct of men . . . . When we overlook such basic laws, we are likely to extrapolate short-term trends into false utopias of brotherhood and peace."

The streamline style did linger on well into the late 1950s as its progenitor, the airplane, played an ever more vital role in the modern world. But its role in shaping American aesthetic and cultural values and symbolizing the promise of a gleaming, technological paradise had long since ended.

ERIC LONG

For a time it provided a new wrinkle in design, but streamlining's days were soon numbered.

Come fly with us!

AIR & SPACE/Smithsonian, the magazine from Smithsonian's National Air & Space Museum, explores the history, culture, and technology of flight.

Travel to the furthest reaches of the universe. Come share the ongoing adventure of man's leap into the blue, as AIR & SPACE/Smithsonian shows you how it's all come about, and where it might lead. Galileo. Amelia Earhart. Billy Mitchell. Sally Ride. The Red Baron. The Blue Angels. Zeppelins. Blimps. Ultralights. Cities in orbit. The new super space scope that will size up Neptune. Issue after issue *AIR & SPACE/Smithsonian* brings aviation's past, present, and future together in one great continuing story. Brightly written. Brilliantly illustrated. Backed by the expertise and full resources of the Smithsonian's National Air & Space Museum.

And along with your subscription to AIR & SPACE/Smithsonian enjoy all these other benefits of membership in the famed National Air & Space Museum.

- Discounts on books, records, art and gifts from all Smithsonian museum shops.
- Eligibility for special foreign and domestic tours.
- Free lectures and reduced rates for Imax films and Planetarium presentations at the National Air & Space Museum.
- Personal membership card and member's welcome at the Museum.

Come sign on now and see why *AIR & SPACE/Smithsonian* is like no other magazine on earth. And take advantage of this opportunity to enter a gift membership for someone else who'd like to be in on what's up out there. Just fill in and mail the coupon below today.

AIR & SPACE
Smithsonian

• Smithsonian Institution Membership-Subscription Center •
P.O. Box 51244 • Boulder, CO 80321-1244

Please enter my one-year membership(s) in the National Air & Space Museum with all special member benefits including a one-year (6 issues) subscription to AIR & SPACE/Smithsonian magazine, and bill me at the rate checked below.

☐ $18 for each membership.
☐ $16 for each membership because I am already a Smithsonian National, Resident, Cooper-Hewitt, Associate, or Contributing Member.

My name _____
(Please print)
My address _____ Apt. _____
City _____ State _____ Zip _____

Gift recipient's name _____
(Please print)
Address _____ Apt. _____
City _____ State _____ Zip _____

Please add $6 for foreign orders and prepay in U.S. funds. 85% of member dues is designated for magazine subscription. Please allow 4 to 6 weeks for receipt of your first copy.

4AWB4

First Over the Channel

On January 7, 1785, U.S. physician John Jeffries and French balloonist Pierre Blanchard lifted off from England's cliffs of Dover in a hydrogen balloon. Bound for the coast of France, they planned to make the first crossing of the English Channel by air.

Though they succeeded, the mission ended up a comedy of errors. Jeffries, who had accompanied Blanchard on a previous ascension, financed the entire operation in return for a seat on the historic flight. However, Blanchard, an aerial prima donna, was loath to share the spotlight. He planned to wear a lead-lined vest to the weigh-in prior to liftoff, which would indicate an overload and get Jeffries bumped. The vest was mistakenly delivered to Jeffries, who chose to overlook Blanchard's eccentricities. He boarded the gondola on a Friday afternoon for a flight with more than its share of ups and downs (including a strikingly novel solution to loss of altitude), all of which he painstakingly recorded in Narrative of the Second Voyage.

The morning was remarkably fine, clear, and serene, but with intense frost. The wind, as far as it could be ascertained, appeared to be about North North-West, or North-West by North; but of that kind which the pilots said did not extend far from the shore; and that the wind usually prevailed in such weather and seasons, and *probably did then prevail,* on the French coast, equally *from that land,* and *in a direct contrary course from what it then appeared to be at Dover*; as at this time there was not wind enough to determine anything by boats or shipping. I was somewhat embarrassed at this idea *from professional men.*

However, observing very light scudding clouds above, which appeared to take a proper direction for our Voyage; and noticing, at the same time, that smoke from the Castle did the same, we determined to proceed accordingly; when having raised a paper kite, and launching a paper Mongolfier [*sic*], and a small gaz Balloon, each of which took, as far as we could trace them, a course favourable to our Voyage, we began to entertain more confidence of success.

The Balloon being filled a little before one o'clock, we suffered it to rise, so as to be disengaged from the apparatus, &c. for filling it, and to be drawn down again just at the edge of the Cliff, where we attached the wings or oars, with the moulinet [winch] and governail [helm], to the Car: And exactly at one o'clock (having in the Car with us, three sacks of sand ballast, of ten pounds each; a large parcel of pamphlets, two cork jackets, a few extra clothes of M. Blanchard; a number of inflated bladders, with two small anchors or grapnels, with cords affixed, to assist our landing) we rose slowly and majestically from the Cliff, which being at the time of our ascent from it almost covered with a beautiful assembly from the city, neighbouring towns and villages, with carriages, horses, &c. together with the extensive Beach of Dover, crouded with a great concourse of people, with numbers of boats, &c. assembled near the shore, under the Cliffs, afforded us, at our first arising from them, a most beautiful and picturesque view indeed.

On this experiment I did not take with me any other philosophical instrument, but my Barometer and Mariners Compass.

At the instant before we rose from the Cliff, the mercury in the Barometer was at 29 inches, seven-tenths; and the wind appeared to be about North North-West, though so much of a calm, as to make the sea appear like a fine sheet of glass.

At a quarter past one o'clock we appeared to have risen considerably, but yet to have made very little progress, and that rather to the Eastward. The weather continued delightful, and we began to have a most enchanting prospect of the distant country back of Dover, &c. enjoying in our view a great many towns and villages; among which I could distinguish the venerable city of Canterbury; but as a counterpart to this pleasing scene, we began to have a very extensive and formidable view of the Breakers, (I judge around the Goodwin Sands) and which we unfortunately seemed to be approaching.

The mercury in the Barometer had now fallen to 27 inches, three-tenths, and we passed over several vessels of different kinds, which saluted us with their colours, as we passed them; and we began to overlook and have an extensive view of the coast of France; which enchanting views of England and France being alternately presented to us by the rotary and semicircular motion of the Balloon and Car (a circumstance mentioned in our former experiment) greatly increased the beauty and variety of our situation.

At half past one o'clock, the Balloon seemed to be distended to its utmost extent, and thereby (as in our former experiment) drew up the Car close to it; on which occasion, recollecting the importance of a sufficiency of inflammable air, to the completion of our Voyage, and that it was not possible to determine exactly, how much of it might escape if we opened the valve, we *only untwisted the two tubes at the bottom of the Balloon,* by which it had been filled with the gaz, and cast them over the sides of the Car; and in a minute or two we had the pleasure to see them become distended through their whole length, beginning at the ends attached to the Balloon. We also had the farther satisfaction to observe, that by this method, no more of the gaz or inflammable air would escape, than was absolutely necessary to relieve the Balloon, and to prevent it from bursting. This period we employed in attaching the bladders we had taken with us, to the circular hoop between our Car and the Balloon.

At 50 minutes after one, (having, I judge, been too inattentive to the state of the tubes on the outside of the Car) I found we were descending fast. We immediately took in the tubes within the Car, and secured them, and cast out one sack of ballast; but the mercury in the Barometer still rising, we cast out half another sack; on which we began to rise, and the mercury again to fall in the Barometer.

We appeared at this time to be about one-third of the way from the English towards the French coast.

We now began to lose all distinct view of the Castle of Dover. At two o'clock we

ILLUSTRATIONS BY MICHAEL DAVID BROWN

attached two small slings to the circle over us, towards each end of the Car, and a third in the middle of it, a little lower than the other two, to rest our feet upon . . . .

We now found that we were descending again; on which occasion we were obliged to cast out the remaining sack and an half of ballast, sacks and all; notwithstanding which, not finding that we rose, we cast out a parcel of the pamphlets, and in a minute or two found, that we rose again; and now appeared to be about mid-way between the English and French coasts.

At about a quarter after two o'clock, I found that we were again descending; this induced us to cast out, by small parcels, all the remaining pamphlets; notwithstanding which, I could barely discover that we rose again.

We had not now any thing left to cast away as ballast in future, excepting the wings, apparatus, and ornaments of the Car, with our cloaths, and a few little articles; but as a counterpart to such a situation, we here had a most enchanting and alluring view of the French coast, from Blackness and Cape Blanez to Calais, and on to Gravelines, &c.

At about half past two I found we were again descending very rapidly, the lower pole of the Balloon next [to] us having collapsed very much, so, that the Balloon did not appear to be three-fourths distended with gaz. We immediately threw out all the little things we had with us, such as biscuits, apples, &c. and after that one of our oars or wings; but still descending, we cast away the other wing, and the governail; having likewise had the precaution, for fear of accidents, while the Balloon was filling, partly to loosen and make it go easy, I now succeeded in attempting to reach without the Car, and unscrewing the moulinet, with all its apparatus; I likewise cast that into the sea. Notwithstanding all which, the Balloon not rising, we cut away all the lining and ornaments, both within, and on the outside of the Car, and in like manner threw them into the sea; after which we cast away the only bottle we had taken with us, which in its descent appeared to force out a considerable steam like smoke, with a hissing or rushing noise; and when it struck the water, we very sensibly (the instant before we heard the sound) felt the force of the shock on our Car; it appearing to have fallen directly perpendicular to us, although we had passed a considerable way during its descent.

As we did not yet ascend, we were obliged, though very unwillingly, to throw away our anchors and cords; but still approaching the sea, we began to *strip ourselves*, and cast away our cloathing, M.

Over the Top *by William S. Phillips, member A.S.A.A., Naval Combat Art Program, Air Force Art Program.*

Blanchard first throwing away his *extra coat,* with his surtout [overcoat]; after which I cast away my *only coat*; and then M. Blanchard his other coat and trowsers: We then put on and adjusted our cork-jackets, and prepared for the event.

We appeared at this time to be about three quarters of the distance towards the French shore, and we were now fallen so low, as to be beneath the plane of the French cliffs. We were then preparing to get up into our slings, when I found the mercury in the Barometer again falling, and looking around, soon observed that we were rising, and that the pleasing view of France was enlarging and opening to us every moment, as we ascended, so as to overlook the high grounds.

I judged that we were at this time about four or five miles from the shore, and appeared to approach it fast. We soon had a fine view of Calais, and a great number of other towns, villages, villas, &c.

We now ascended to a much greater height than at any former period of our voyage, and exactly at three o'clock we passed over the high grounds between Cape Blanez and Blackness; thus forming in our ascending entrée a most magnificent arch; at which time, nothing can exceed the beautiful appearance of the villages, fields, roads, villas, &c. under us, after having been just two hours over the sea.

The mercury in the Barometer had now fallen to 23 inches, three-tenths; at which time a packet of letters, cast out by M. Blanchard, was several minutes in reaching the surface of the earth, and afforded an amusing scene to us, in observing it during its descent; it appearing, in its progress, to pass along over inclosures, houses, roads, &c. as if running after us; and finally settled in a field, in a straight line perpendicular to us.

From this circumstance of the manner of the descent of the packet, I am led to suspect, that my idea of taking the balls with me, to assist (by their descent) the Compass in determining our course, was a mistaken one; and to apprehend that I should not have derived from them that assistance which I sought.

The weather still continued fine, and very clear; the rays of the sun, though almost horizontal, shining very bright; but from the height which we were now at, and from the loss of our cloaths, we were almost benumbed with cold.

By our velocity, the wind seemed now to be considerably increased; and from our course I judge it must have been more westerly than before, as we appeared to be approaching fast to the grounds covered with water on our left, above, and a little to the right of Calais; but in a few minutes, I perceived that we had again changed our course, which was now towards the South-West, and that we were gradually descending; to favour which, we untied our slings, and took off our cork-jackets, (being the only things we had then left, excepting the Barometer) to cast away as ballast occasionally.

We now found ourselves approaching towards a forest, which appearing to be more extensive than it was probable we should be able to pass entirely over, we cast away one cork-jacket, and soon after it the

other, which almost immediately checked, and altered the angle of our descent. We had now approached so near to the tops of the trees of the forest, as to discover that they were very large and rough, and that we were descending with great velocity towards them; from which circumstances, and from the direction of our course at this time, fearing that the Car might be forced into some of the trees, so violently as to separate it from the cords that connected it with the net which covered the Balloon, I felt the necessity of casting away something, to alter our course; happily (it almost instantly occurred to me, that probably we might be able to supply it from within ourselves), from the recollection that we had drank much at breakfast; and not having had any evacuation; and from the severe cold, little or no perspiration had taken place, that probably an extra quantity had been secreted by the kidneys, which we might now avail ourselves of by discharging. I instantly proposed my idea to M. Blanchard, and the event fully justified my expectation; and taking down from the circle over our Car two of the bladders, for reservoirs, we were enabled to obtain, I verily believe, between five and six pounds of urine; which circumstance, however trivial or ludicrous it may seem, I have reason to believe, was of ***real utility*** to us, ***in our then situation***; for by casting it away, as we were approaching some trees of the forest higher than the rest, it so altered our course, that, instead of being forced hard against, or into them (as at that instant appeared probable that we should be), we passed along near them in such a manner, as enabled me to catch hold of the topmost branches of one of them, and thereby arrest the farther progress of the Balloon, which, almost the instant the Car touched the trees, so as to take off a part of its weight, was disposed to ascend again; and in that position continued for a considerable time, waving over our heads, making a very pretty appearance above the woods, until, having for some time held the valve open, a sufficiency of gaz had escaped, to dispose the Car to settle on the branches, when, by disengaging, and pushing it from one to another, we found a sufficient space between the trees to admit us to descend tranquilly to the surface of the ground, a little before four o'clock, it having been about half after three when I first stopped the progress of the Balloon over the forest; which I have since been informed, is called the *Forest of Guines*, not far from *Ardres*, and near the spot celebrated for the famous interview between Henry the Eighth, King of England, and Francis the First, King of France.

As the Worm Turns

The sound of the Flyworm's demise was an awful cacophony of rending and roaring. Fortunately, the aircraft was still on the ground; it fell apart while spooling up for its first flight test.

It was the fall of 1929; the place, a parking lot in San Diego's Mission Beach amusement park. The newsreel cameramen filming the effort for posterity laughed as they recorded the disaster.

The ill-fated contraption didn't look at all like an airplane. It was best described as something akin to a cement mixer with a fat wing and training wheels. Paul Maiwurm, the realtor and part-time inventor who created it, called it the Maiwurm Cyclonic Aircraft 660E—or, more informally, the Flyworm—and swore it would be the fastest, quietest, and most economical thing in the air. He was wrong.

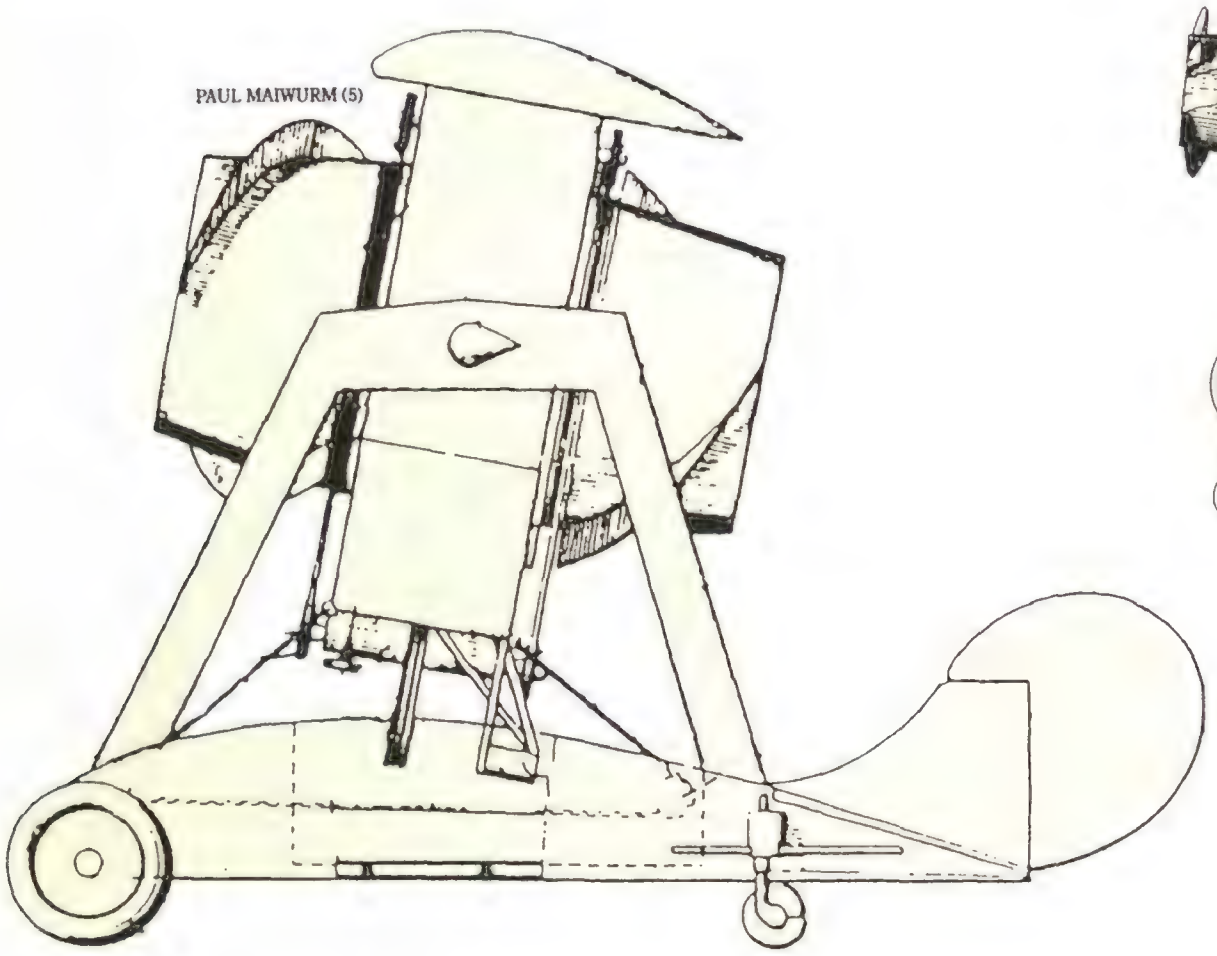
Maiwurm was no neophyte inventor. He had designed the first automatic drink dispenser, the Drink-O-Mat, which vended root beer in the lobby of San Diego's Broadway Theatre.

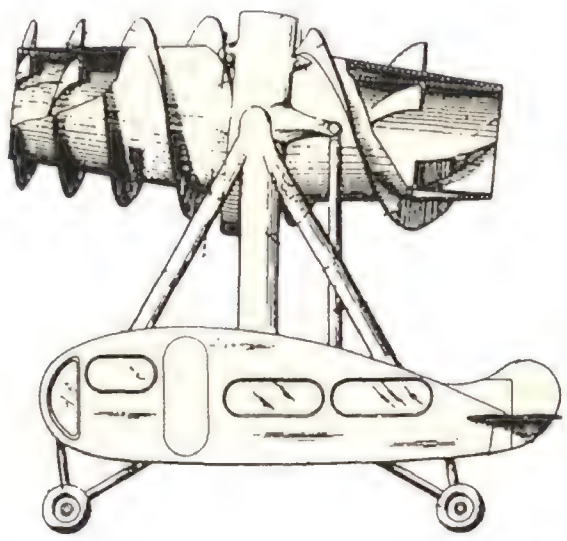
Maiwurm thought the 660E would be his crowning glory. In the two years following Lindbergh's lonely flight to Paris, aviation had burgeoned into a major industry. Airmail, now systematic and dependable, was being outstripped by passenger traffic. Aeronautics was the new frontier, and Maiwurm had a pioneering idea.

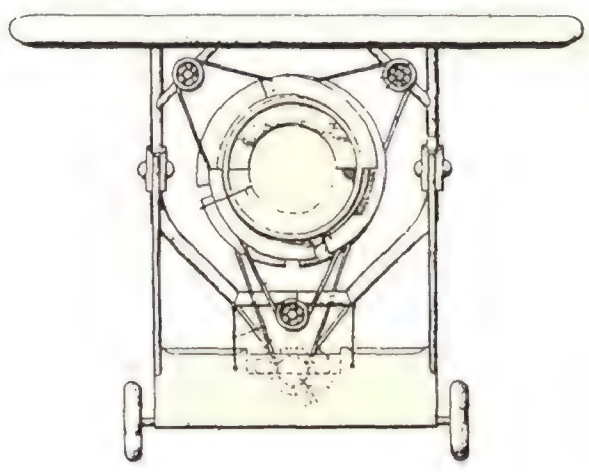
His vision took the form of a 6-foot-long barrel topped with a stubby wing and suspended over a steel tube base that had four wheels. An 80-horsepower Le Rhone rotary engine was supposed to turn the "rotating tubular wing" at 200 to 300 rpm. The pilot, seated in the cage-like cockpit slung below, would tilt the barrel upward by means of an automobile steering wheel connected to a series of pulleys and cables. Once up to speed, Maiwurm predicted, the spiral of fins around and inside the barrel would create a "cyclone" whirling out the aft end that would allow nearly vertical takeoffs and landings. For cruise flight, the barrel would be returned to a horizontal position.

"Inspiration for this tubular design came to me many years ago in California," Maiwurm wrote in a 1930 treatise, "at a time when I was suffering from a nervous breakdown." The inventor had spent his recuperation studying the aerodynamics of the hummingbirds that fed on the

PAUL MAIWURM (5)







honeysuckle outside his window. "Time will show the correctness of my calculations, I hope," he wrote, "and the rotating-tube aircraft will take its place among the great inventions of the age."

Maiwurm initially demonstrated the Great Invention with a cylindrical oatmeal box. He removed both ends and fastened a one-inch-wide spiral of cardboard inside. He would then hold the box over his head and give it a sharp twist as he tossed it forward. The box was said to have sailed almost a block each time.

In May 1928 Maiwurm applied for a patent on the aircraft and in August, with the help of local mechanics, started knocking together the 660E in a Belmont Park workshop. In autumn of the following year he decided it was ready for a test flight. But the Flyworm thought otherwise.

Before starting the engine, Maiwurm tied the 660E to a telephone pole to be sure his aircraft wouldn't leave the ground without him. He then fired up the Le Rhone. The barrel rotated slowly, then picked up speed. Maiwurm smiled and headed for the pilot's seat.

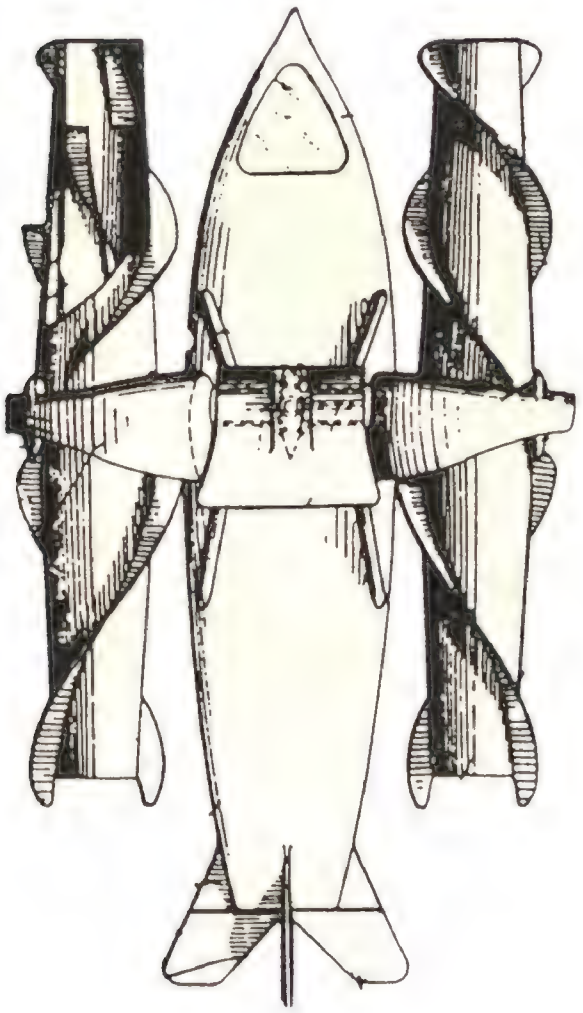
Suddenly the giant U-shaped yoke that supported the big cylinder gave out. The 200-pound engine fell through the cockpit, which Maiwurm had not yet reached.

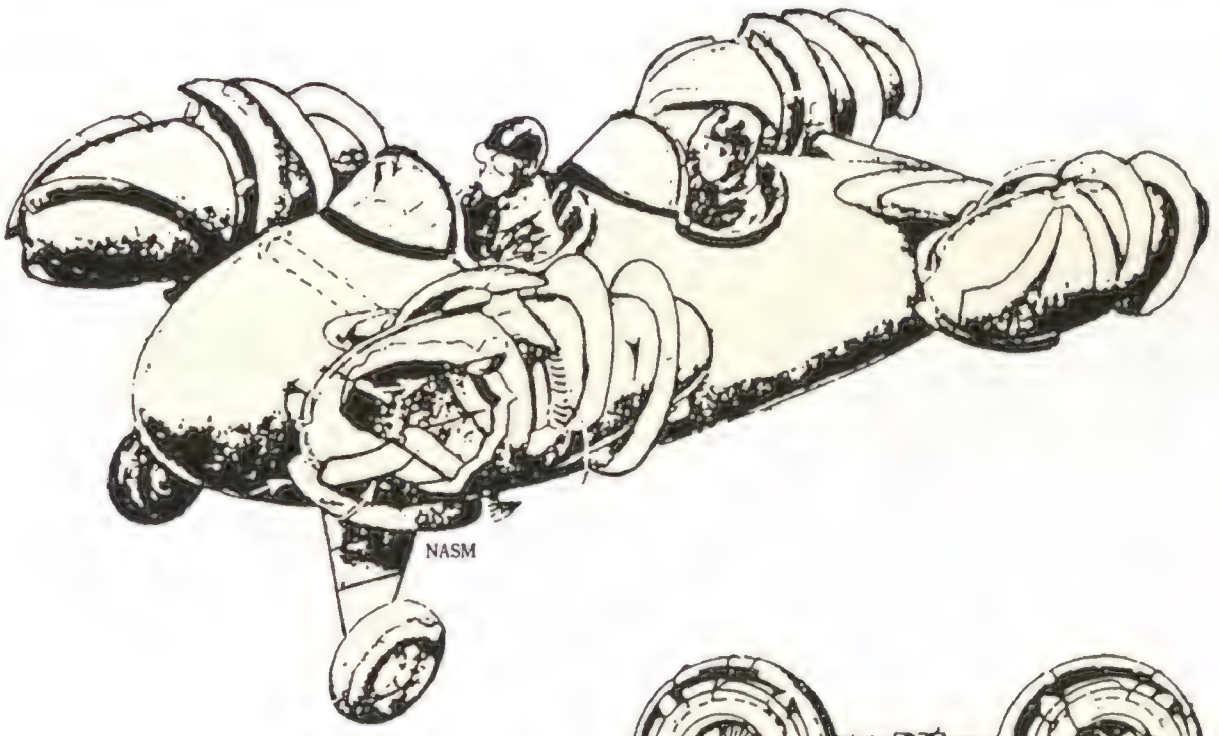
The Flyworm was smashed, but not so its inventor's aspirations. Maiwurm was determined to build another 660E. Neighbors whispered that the Flyworm ought to be renamed the Phoenixworm, but others observed that at least the phoenix *flew* before it self-destructed.

Maiwurm stationed himself in front of local theaters and buttonholed pedestrians out to take the air, trying to sell them shares in the Flyworm Corporation of America. When the authorities heard about his unorthodox solicitations, they ordered him to cease and desist. Maiwurm left town in a huff.

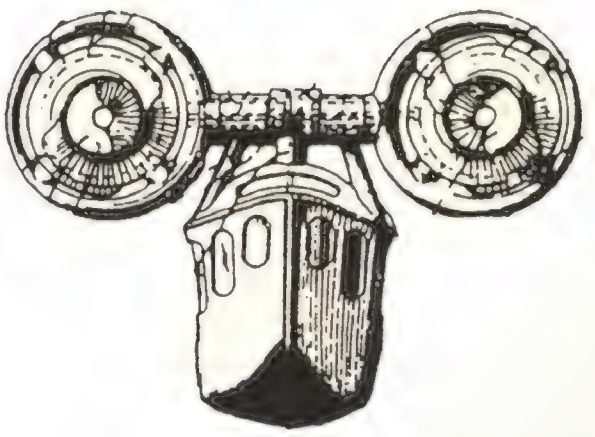
In 1935 he surfaced in New York City, promoting a streamlined four-engine version of the Flyworm that presaged today's V-22 tilt-rotor. But back on the West Coast, the first Flyworm resurfaced regularly—daily, in fact. The inventor had evidently dumped the prototype's remains into Mission Bay, and at low tide the residents of Santa Barbara Street could see a Flyworm wing jutting out of the water.

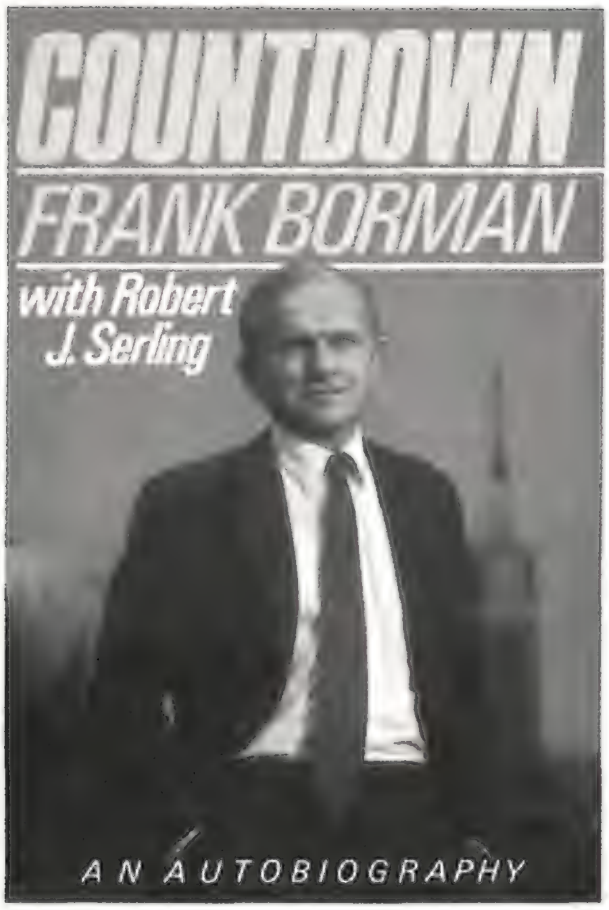
—Phil Cohan





NASM





Countdown: An Autobiography *by Frank Borman with Robert J. Serling. Silver Arrow Books, 1988. 448 pp., b&w photos, $19.95 (hardbound).*

Schirra's Space *by Walter M. Schirra, Jr. with Richard N. Billings. Quinlan Press, 1988. 227 pp., b&w photos, $16.95 (hardbound).*

Twenty years have passed since the first two Apollo missions, and now their commanders, Wally Schirra and Frank Borman, have joined the growing list of astronauts-turned-authors. Though their books are sure to interest space enthusiasts, they are not, strictly speaking, space books. Rather, they are memoirs of careers that spanned more than two decades of aviation and space history and continued into the lesser-known realm of life after splashdown.

Throughout his adult life Borman had one focus: the mission at hand. It was a single-minded dedication that began at West Point, was honed in his years as an Air Force fighter pilot, reached its peak in his years as an astronaut, and sustained him through a long and often agonizing tenure as the president of Eastern Airlines. *Countdown* covers each of Borman's three careers in considerable detail.

Borman is best known for commanding the first flight around the moon, Apollo 8, in December 1968. But as described in *Countdown*, that mission was far less stressful than his Gemini 7 mission three years earlier. Crammed into a tiny, overheated cockpit, he and copilot Jim Lovell toughed it out for two weeks in Earth orbit, grateful for each time they got permission to peel off their lightweight spacesuits. After 11 days their routine was broken by a brief visit from Wally Schirra and Tom Stafford in Gemini 6—the first space rendezvous. Though they were subsequently plagued by failing thrusters and fuel cells, Borman and Lovell stayed aloft for three more days, which Borman calls "the longest of our lives." He admits to being worried enough that he was ready to come down early, but credits flight director Christopher C. Kraft Jr. with saving the 14-day mission.

Only Borman's family competed with his dedication. The conflict between the two kept him awake the night before each of his two spaceflights. But it was Borman's wife Susan who suffered most, enduring secret terror over her husband's risky profession. Borman did not know his wife had a drinking problem until, after years of being the Perfect Astronaut's Wife, she suffered a nervous breakdown in 1973.

Borman's astronaut colleagues remember a gruff, dogmatic figure who had the aura of command and rarely cracked a joke. But the Frank Borman that emerges from the pages of *Countdown* is a man of deeply felt emotions. Particularly telling is the account of the Apollo 1 fire, which killed Gus Grissom, Roger Chaffee, and Borman's close friend Ed White in 1967.

But Borman's emotions run highest in the account of his years at Eastern. In 1978 he and the airline industry were "dragged kicking and screaming into deregulation," and before long his troubles began to build. Beset by high labor costs, divided management, and low employee morale, Borman waged a battle for control of the airline against strong-willed union leader Charles Bryan. It proved to be a battle that Borman could not win. Eastern was sold to Texas Air on February 23, 1986, and as Borman writes, "[f]or the first time in my life, I hadn't accomplished a mission."

Wally Schirra, on the other hand, "had one hell of a good time," and he goes on to prove it in a breezy, pun-filled narrative that reads like a long conversation. One minute he is delightedly recalling one of his famous "gotchas" (example: filling a five-gallon jug with warm water, iodine, and detergent and leaving it for the NASA nurse as a urine sample). Then he is describing the delicate piloting necessary to make that first space rendezvous with Borman's Gemini 7, a task unforgiving of even minute errors. And then he is on his self-described soap box, broadcasting his views on the state of the space program (we don't need a shuttle that carries politicians, teachers, and journalists,

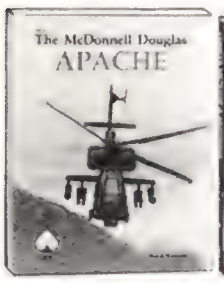
An absolutely no-risk guarantee.

Puts you on course with the latest, most authoritative information—at big savings!

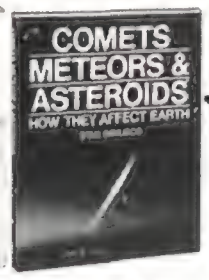
Select 5 Books for $3.95

(values to $122.70)

and get a Free Gift!



20614 $10.95



1905 $14.95

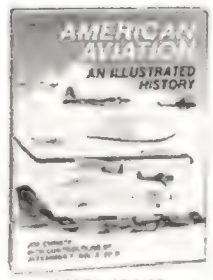
22399H $14.95

2413 $14.95

2397 $29.50
Counts as 2

26624 $12.95

2390 $15.95

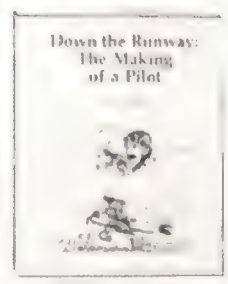


2497 $24.95
Counts as 2

22396H $16.95

24180 $14.95

2326 $13.95



2425 $10.95

22386 $15.95

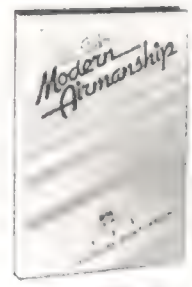
2384 $17.95

2846 $6.95

2423H $27.95
Counts as 2

2946H $18.95

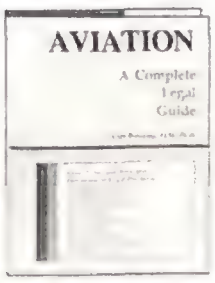
2327 $21.95
Counts as 2



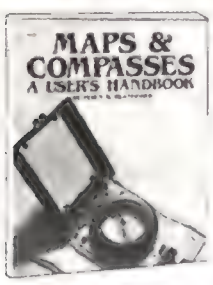
2411H $37.50
Counts as 2

2420 $14.95

26456 $15.95



2414H $19.95



1644 $11.95

2403 $14.95

28515H $14.95

9077P $13.95

2415H $23.95
Counts as 2

22923 $14.95

The AVIATORS' GUILD®

FREE when you join!

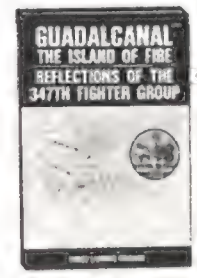
Space Shuttle Log: The First 25 Flights

". . . fascinating insight into space shuttle trials, triumphs. When you finish this book you will be left with a feeling of awe over what was accomplished in the first 25 missions. But even more you will be left with an extraordinary sense of what we have yet to learn."

—The Star Ledger

Membership Benefits • **Big Savings.** In addition to this introductory offer, you keep saving substantially with members' prices of up to 50% off the publishers' prices. • **Bonus Books.** Starting immediately, you will be eligible for our Bonus Book Plan, with savings of up to 80% off publishers' prices. • **Club News Bulletins.** 13 times per year you will receive the Book Club News, describing all the current selections—mains, alternates, extras—plus bonus offers and special sales, with hundreds of titles to choose from. • **Automatic Order.** If you want the Main Selection, do nothing and it will be sent to you automatically. If you prefer another selection, or no book at all, simply indicate your choice on the reply form provided. As a member, you agree to purchase at least 4 books within the next 12 months and may resign at any time thereafter. • **Ironclad No-Risk Guarantee.** If not satisfied with your books, return them within 10 days without obligation! • **Exceptional Quality.** All books are quality publishers' editions especially selected by our Editorial Board. AS289

All books are paper unless number is followed by an "H" for hardbound.



22389 $16.95

2392 $14.95

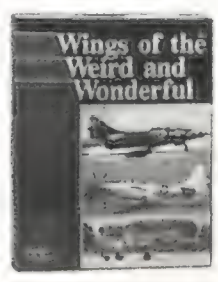
22392 $14.95

2942H $24.95

2477 $12.95

22394 $19.95

28512V $9.95



2404H $19.95

(Publishers' Prices Shown)

If card is missing, use this address to join:

Schirra says; we need a space station).

In between, Schirra offers some revealing new details of his spaceflights, including an interesting account of his Apollo 7 mission in October 1968. Schirra was often testy with mission control during the 11-day flight, a reaction chalked up to the astronaut's "dark side," aggravated by a severe head cold he suffered during the flight. But Schirra reveals that he was also nursing a grudge. Flight controllers gave the go-ahead to launch Apollo 7 in unfavorable winds, he says, despite a preflight agreement to the contrary. Had Schirra been forced to abort during the first minutes after liftoff, the command module would have drifted back across Florida as it descended on parachutes, finally landing in a tremendous jolt that would almost surely have injured him, Donn Eisele, and Walt Cunningham. This breach of faith, Schirra says, was on his mind during his strained conversations with Earth. With Apollo 7 Schirra ended his flying career; the 45-year-old veteran says he had been "devoured" by the endless grind of training for space.

The biggest weaknesses in these as-told-to accounts are stylistic. Robert Serling has woven an entertaining narrative, but at times he seems to have polished Borman's rough edges a little too smooth, and some of the re-created conversations seem decidedly unauthentic. Richard Billings seems to have left Schirra's meandering style intact, resulting in a book that is less readable than it might have been. And both books suffer from occasional historical inaccuracies, even in the accounts of the authors' own missions. But these minor flaws should not deter readers who want to indulge in some timely reminiscing by a couple of space pioneers.

—Andrew Chaikin is writing the story of the Apollo astronauts and their missions, to be published later this year by Viking.

***F-19 Stealth Fighter** by Microprose, Inc. Available for the IBM PC, XT, AT, PS/2, Compaq 386, Tandy 1000. 384K RAM, color monitor or Hercules Monochrome required. DOS 2.1 or higher; IBM, Microsoft, Tandy. Joystick optional but recommended. Reviewed on an IBM with an EGA screen. $69.95.*

The Middle East situation is heating up. You're on a vital mission, behind the controls of the most secret jet fighter in the U.S. arsenal: the F-19 Stealth Fighter (recently unveiled, after years of secrecy, by the Air Force as the F-117A). As you head in for an attack on an enemy base,

target images flash across the tactical display screen. However, the enemy's guided-missile ships, surface-to-air missile sites, and MiG fighters do not respond to your presence; your airplane is invisible to radar. Now it's time to close in and finish the job . . . .

Sound exciting? It should, because Microprose, a Maryland-based software company, has developed a realistic, meticulously designed computer game that combines the radar-evading stealth concept with challenging scenarios and sophisticated imagery.

F-19 begins with a preflight intelligence briefing so the player can select combat regions, enemy targets, and skill levels. The next step is to take off from an aircraft carrier or runway and head for the target, all made easier by a wide-screen cockpit and a detailed head-up display (HUD) that lists direction, speed, altitude, G forces, and targeting controls.

Switch on the autopilot after takeoff and activate the Internal Navigation system. Pre-selected waypoints automatically guide the F-19 to the proper target heading. You can also monitor a satellite/radar map that shows your position alongside familiar references. The navigation system also activates the tactical display map, which enables you to observe enemy positions. And with the help of the Electro-Magnetic Visibility scale, you can monitor the F-19's "visibility" to enemy air and ground radar.

With the F-19 on course and approaching target, you can plot attack strategy with the camera/data screen. This tells you when you'll arrive at the target and gives you the the exact distance so you can lock on and fire air-to-ground missiles.

If your mission requires any air-to-air combat, you'll discover that the F-19 is outmatched by MiG fighters and must rely more on its ordnance, navigational abilities,

and electronic defenses for survival. However, the F-19 pilot can take advantage of a complement of simulation controls, such as "out of plane" viewing with zoom capability, which provides a fascinating array of aerial perspectives. This kind of inventiveness brings a fresh dimension to computer gaming.

F-19 provides realistic, sweat-producing combat situations and often dazzling graphics. It also comes packaged with colorful target maps and a nearly 200-page instruction booklet that quickly familiarizes the uninitiated player with the game's basic concepts. Any mission, whether a success or failure, will be a job well worth the effort.

—Ken Isbell works for the National Air and Space Museum's space science and exploration department.

***The Doolittle Raid: America's Daring First Strike Against Japan** by Carroll V. Glines. Orion Books, 1988. 258 pp., b&w photos, $17.95 (hardbound).*

***The Doolittle Raid** by Duane Schultz. St. Martin's Press, 1988. 325 pp., b&w photos, $18.95 (hardbound).*

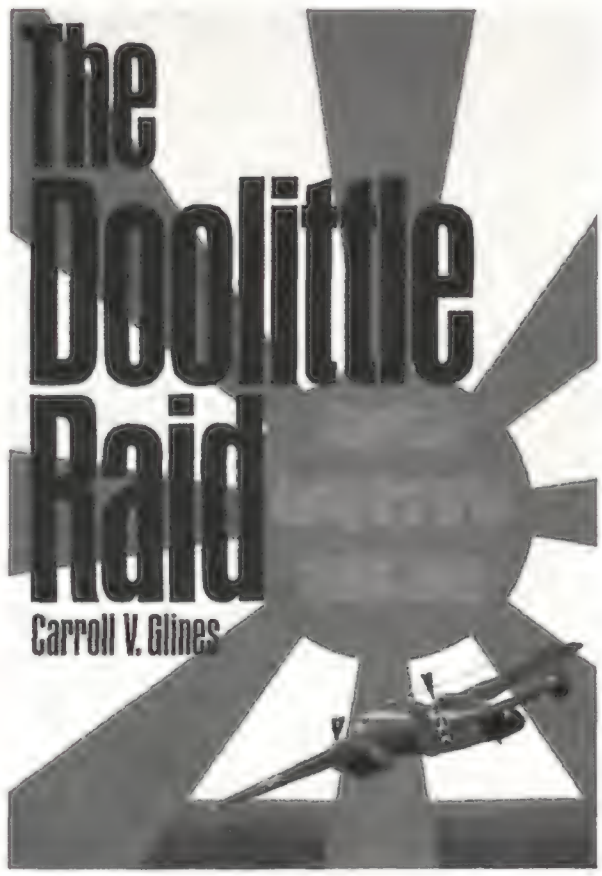
Coincidence is an unfortunate fact of life in publishing: when two books with a common topic appear at the same time, one is apt to suffer by comparison. Such is the case with these two accounts of Lieutenant Colonel James Doolittle's bombing raid on Japan just four months after Pearl Harbor.

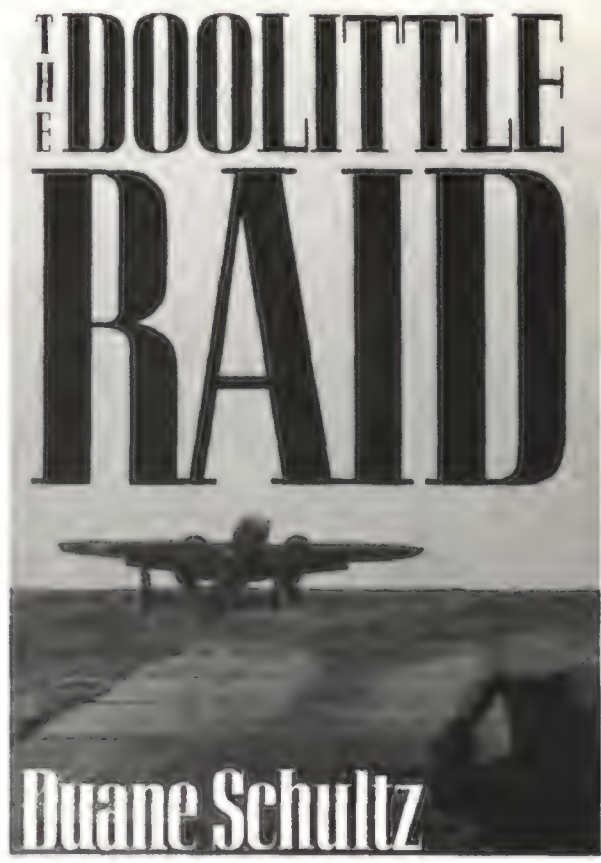
Much of the impetus for the Doolittle raid, notes historian Carroll Glines, came from President Roosevelt himself. On December 21, 1941, Roosevelt told his chiefs of staff that he "wanted a bombing raid on the home islands of Japan as soon as possible to bolster the morale of America and the Allies." Glines neglects to mention, however, that the president had given his go-ahead five months earlier for U.S. crews and bombers to strike Japan from bases in China. In his superior retelling of the tale, Duane Schultz remarks that "Japan won the race for executing a surprise attack, and this fact may have increased Roosevelt's antipathy."

Schultz offers a wealth of biographical detail about the 45-year-old former test pilot (and Ph.D. in aeronautical engineering) who led 16 B-25s from the carrier *Hornet* to the flak-filled skies of Japan on April 18, 1942. Jimmy Doolittle was "the smallest boy in school," notes Schultz, and his "hair was kept in long curls like a girl's." Doolittle "learned to fight in order to survive."

Like the pugnacious Doolittle, the

bomber picked for the mission—the B-25 Mitchell—was "fast, hard-hitting and full of fight," according to the pilots who first flew it in April 1941. The choice of aircraft was actually a simple one: Army Air Corps and Navy planners needed a bomber that could take off from a 500-foot flight deck carrying a 2,000-pound payload of incendiaries and high explosives, then fly 2,000 miles without refueling. Of the limited number of medium bombers at the Army's disposal in the spring of 1942, only the twin-engine, twin-tail B-25 fit the bill.





Both authors suspensefully re-create Doolittle's campaign to modify the bombers and train their crews within the 12-week deadline imposed by weather patterns in the western Pacific. During that time, the airplanes' fuel capacity was raised from 646 to 1,141 gallons by the addition of reserve tanks, and the B-25 pilots learned to take off in the requisite 500 feet (one hotshot, reports Schultz, managed to get airborne in less than 300).

As the *Hornet* and its task force steamed to within 620 miles of Japan on the morning of April 18, a Japanese picketboat detected their approach. This forced Doolittle and his 79 fellow raiders to take off 12 hours ahead of schedule, but all 16 bombers made the wavetop dash to the Japanese coast unscathed.

Although both books characterize Japan's air defenses as "formidable," they differ in their counts of how many interceptors stood ready to greet the raiders. Glines says that "nearly 100 Type 97 (Nate) single-engine fighters were in place around the country's major cities," whereas Schultz quotes a U.S. intelligence officer who estimated the number at over 500. The authors agree, however, that the staggered (and therefore unpredictable) pattern of attack helped the B-25s survive their bombing runs over Tokyo and the four other target cities. A Doolittle ploy—fitting the tail sections with broomsticks painted black to simulate machine gun barrels—apparently dissuaded many Japanese fighters from coming within killing range of the invaders.

Having dropped their bombs, the B-25s rode a 40-mph tailwind to the Chinese coast 1,200 miles distant, where the crews bailed out, crash-landed, or ditched in the sea. The exception was a five-man crew that touched down in "neutral" Soviet territory near Vladivostok; the men sat out much of the war in a Russian jail before they were able to escape into Iran.

Tragedy, victory, and secrecy were the legacies of the Doolittle raid. Some 250,000 Chinese, most of them civilians, died in a Japanese reign of terror intended to punish those who had helped the fliers escape and to deter the populace from offering any such aid in the future. The U.S. Navy, meanwhile, succeeded in repulsing Japan's attempt to seize Midway Island and prevent a recurrence of Doolittle-style raids. And while Schultz has chosen to analyze and reflect on the U.S. public's reaction to the government "cover-up" of the raid, Glines simply dismisses these responses as a "minor note of discontent in the United States."

Ultimately, Glines' somewhat dutiful portrait falls short of Schultz's more

detailed canvas. In their enthusiasm for the subject, however, both authors have painted compelling accounts of the ordeals that began with Jimmy Doolittle's hair-raising "30 seconds over Tokyo."

—Allan Fallow is an editor at Time-Life Books.

Above Top Secret: The Worldwide UFO Cover-Up *by Timothy Good. William Morrow and Co., 1988. 591 pp., b&w photos, $19.95 (hardbound).*

British "ufologist" Timothy Good tackles a twofold question in this massive tome: What evidence of UFOs do various governments have, and does the existence of government documents dealing with UFOs point to a covert program aimed at withholding knowledge of the subject?

That reams of such documents exist is not in dispute. The CIA alone, after repeated denials, has surrendered some 1,000 pages of documents related to UFO sightings. Good's bulging appendix contains approximately 100 such "official" reports, drawn from an international stew of acronymous military and intelligence agencies, including the FBI, DIA, NSA, and England's RAF and MoD, among others.

But how ominous is the presence of such dread initials at the top of a document, classified or otherwise? Is it really the kiss of conspiracy, as Good claims, the telltale trail of a worldwide cover-up? In many cases, evidence within the very documents Good cites belies the existence of any supersecret government UFO plot. And Good seems unaware that most intelligence agencies, like all bureaucracies, are composed of paper shufflers who stuff every last shred of incoming information into vast filing cabinets.

In fact, it would be a mystery and a conspiracy (at least of incompetence) to find *no* UFO reports in the CIA's files, given the number of file clerks employed at the agency's Langley, Virginia headquarters. What seems absent at this point is evidence that those reports stimulated much beyond cursory clipping and common curiosity.

Consider the view taken by another ufologist, Jacques Vallée. "If the government was trying to hide the Andromeda Nebula," he asks, "do you think that would stop me from dragging my own telescope into the backyard to have a look?" Good has used a microscope instead. In the process he may have spied a mountain where in fact there is a molehill.

—Dennis Stacy edits the MUFON UFO Journal.

Credits

George On My Mind. O.H. Billmann is an aviation technical advisor to U.S. and foreign military services.

Southern Comfort. Edwards Park is a frequent Flights & Fancy contributor.

The Place-That-Looks-Like-Mars Mission. *Sky & Telescope*'s senior editor J. Kelly Beatty covers space exploration. Beatty admits he couldn't draw a straight line to save his life.

Air Power on Ice. Noel Vietmeyer is a researcher for the National Academy of Sciences, for which he has written over 30 publications. His freelance work has appeared in *Smithsonian, Reader's Digest,* and *National Geographic.*

Further reading: *Pyke: The Unknown Genius,* David Lampe, Evans Brothers Limited, 1959.

"That Was the War: Enemy Alien," M.F. Perutz, *The New Yorker,* vol. 61, no. 25, August 12, 1985.

If These Bags Could Speak . . . Airplane buff Alan G. Ampolsk is a New York City-based writer who has been published in *New York Magazine, Manhattan Inc.,* and *Good Housekeeping.* He always carries his luggage on board.

An internationally known illustrator and designer, Michael David Brown teaches at the Maryland Institute, College of Art in Baltimore. For this issue, Brown also illustrated "George On My Mind" and "First Over the Channel."

Further information: For tips on handling lost luggage, send $2 for "Facts & Advice for Airline Passengers," a pamphlet by the Aviation Consumer Action Project, P.O. Box 19029, Washington, DC 20036.

The Aurora Patrol. John W. Briggs, a physics student at San Jose State University, is a former assistant editor at *Sky & Telescope.*

Further reading: *Majestic Lights: The Aurora in Science, History, and the Arts,* Robert H. Eather, American Geophysical Union, 1980.

The Once and Future Bomber. Richard Wolkomir has contributed to *Discover, Playboy,* and *Natural History.* His last story for *Air & Space/Smithsonian* was "Looking Down on History" in the August/September 1988 issue.

Further reading: *Flying Blind: Decision Making in the U.S. Strategic Bomber Program,* Michael Edward Brown, Cornell/University Microfilms, 1983.

The Jet Makers: The Aerospace Industry From 1945 to 1972, Charles D. Bright, Regents Press of Kansas, 1978.

Boeing B-52, A Documentary History, Walter Boyne, Jane's, 1981.

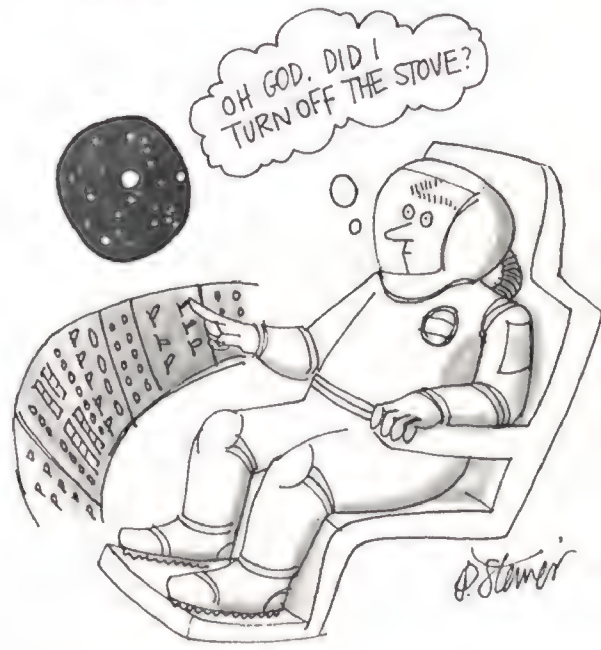
Get 'em Up, Scout! A former *Reader's Digest* roving editor, Joseph A. Harriss is a freelance writer living in Paris.

The Age of Streamlining. Dominick Pisano is an associate curator for the National Air and Space Museum's aeronautics department.

Further reading: *Twentieth Century Limited: Industrial Design in America 1925–39,* Jeffrey L. Meikle, Temple University Press, 1979.

The Streamlined Decade, Donald J. Bush, George Braziller, Inc., 1975.

As the Worm Turns. Phil Cohan is a frequent contributor to *Air & Space/Smithsonian.*



"The Satellite Sky" Update/11

These regular updates to **"The Satellite Sky"** chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

Deletions

90 to 300 MILES

Cosmos 1834
down 10-14-88

Cosmos 1973
down 10-10-88

Cosmos 1969
down 11-13-88

Progress 38
down 11-23-88

300 to 630 MILES

San Marco D/L
down 12-5-88

Launched but not in orbit

90 to 300 MILES

Buran USSR research	11-15-88	down 11-15-88
Cosmos 1976 USSR photo recon	10-13-88	down 10-27-88
Cosmos 1978 USSR photo recon	10-27-88	down 11-10-88
STS-27 Atlantis USA surveillance	12-2-88	down 12-6-88

Inoperative but still in orbit

90 to 300 MILES

Cosmos 1900

300 to 630 MILES

Cosmos 1862

21,750 to 22,370 MILES

GOES 4

Correction to Update/10
Rename TDRSS-2 (New launches, 21,750 to 22,370 MILES) TDRSS-3. TDRSS-2 was destroyed in the *Challenger* explosion.

New launches

90 to 300 MILES

300 to 630 MILES

21,750 to 22,370 MILES

A special edition of **"The Satellite Sky"** is available on deluxe paper and unfolded.

To order: Send $6 UPS Postage Paid to:

Satellite Poster
Air & Space/Smithsonian Magazine
National Air and Space Museum
7th & Independence Avenue
Washington, DC 20560

Name

Address

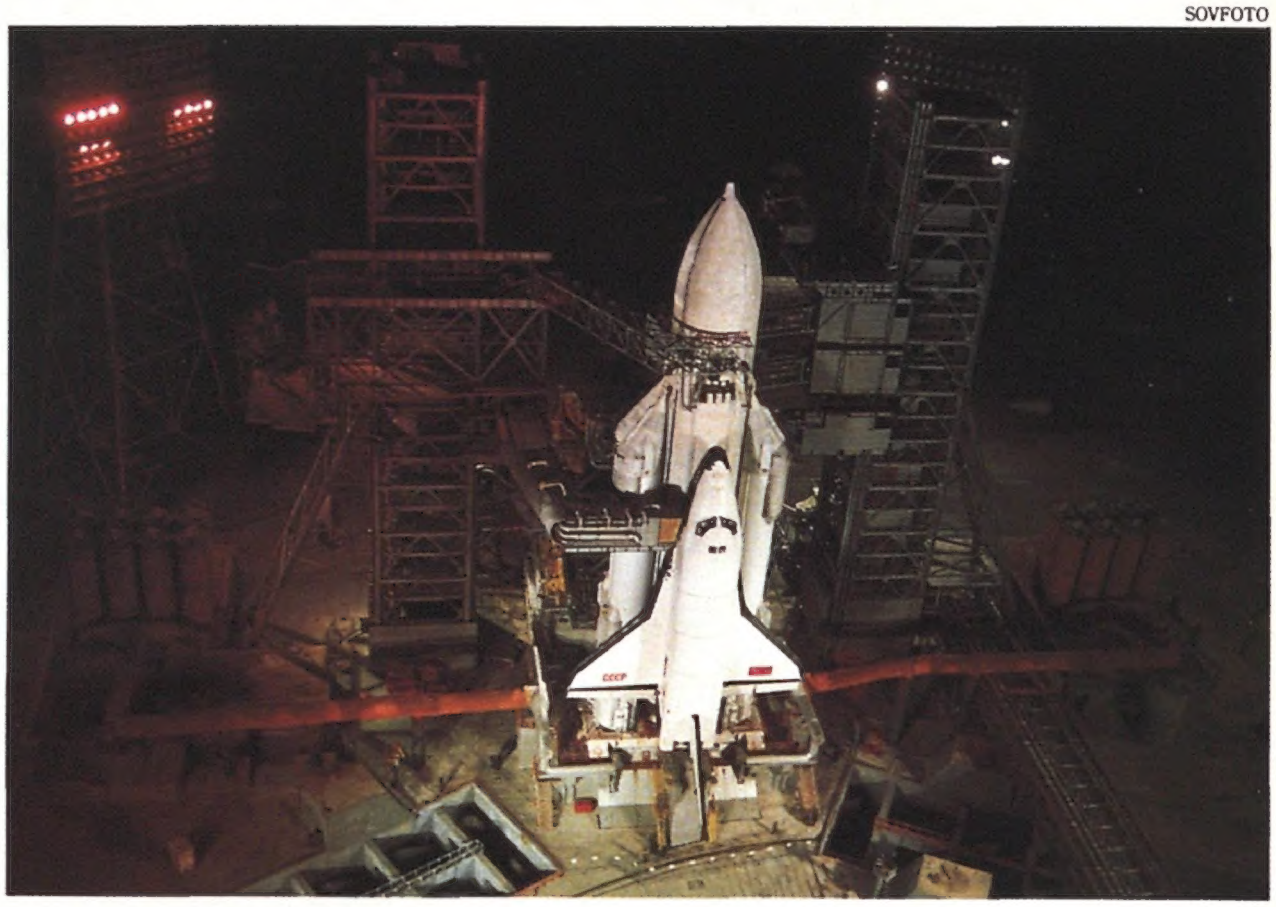
City

State Zip

Forecast

In the Wings...

SOVFOTO



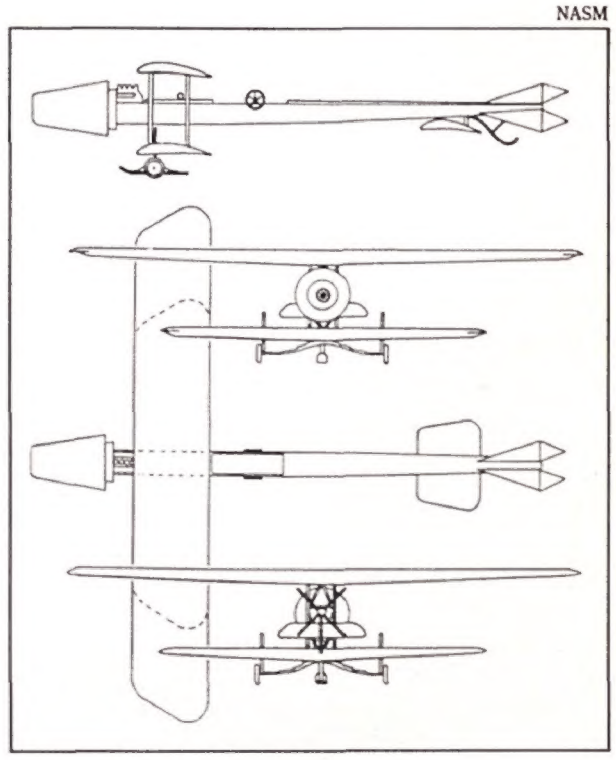
Whither Energiya?—The Soviet Union's colossal booster, now used to loft their shuttle into orbit, has also launched worldwide speculation on its ultimate purpose. Will it carry components for a space station? Launch a fleet of satellites to convert sunlight into electricity? Or will it transport space-based weapons? Four space experts discuss the potential of the world's largest rocket.

"Eject! Eject! Eject!"—When the bailout order comes, pilots take a wild ride on a rocket-powered seat.

Spacecraft Restoration—In a drab building in Kansas, carpenters and auto body specialists turn space junk into museum pieces.

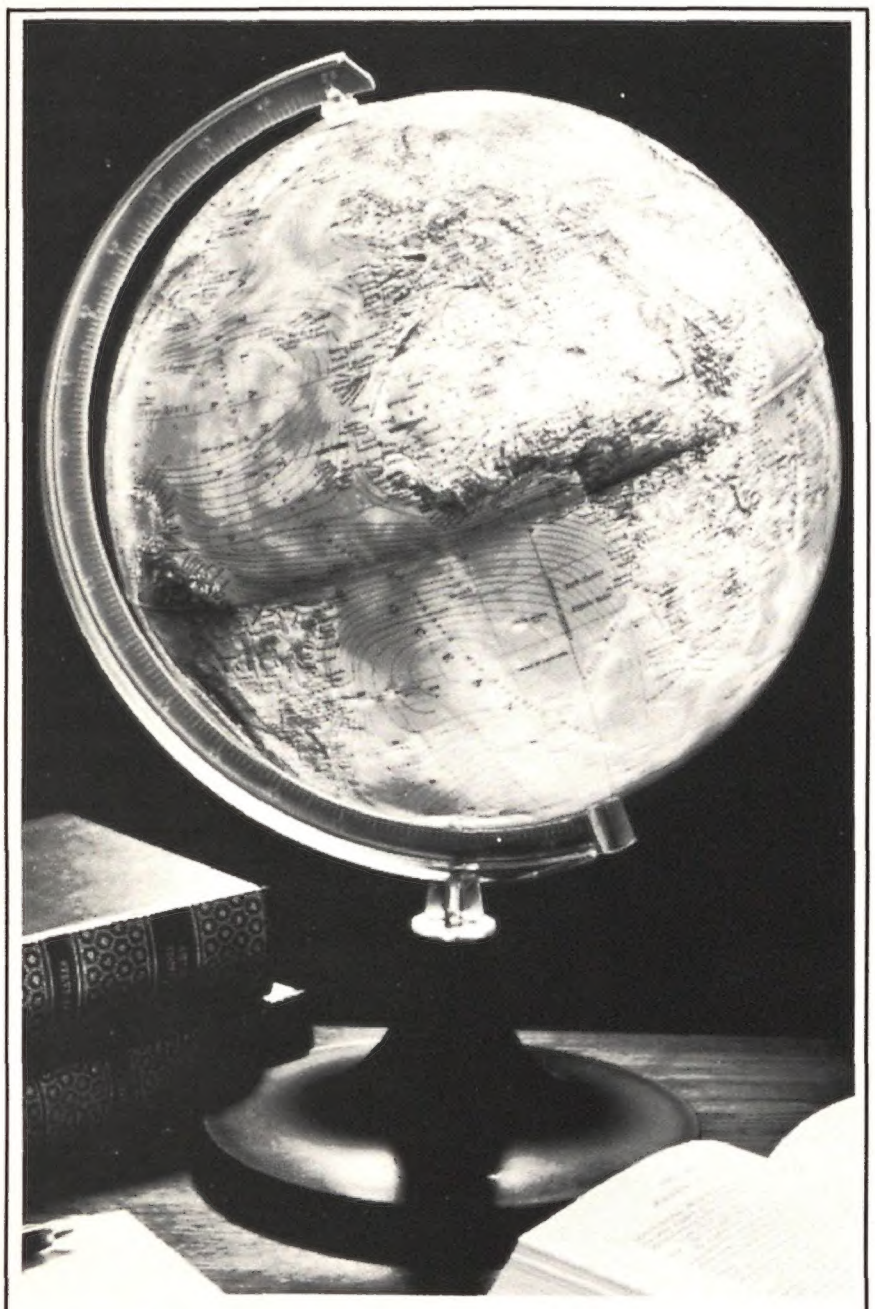
Coanda—In 1910 Henri Coanda began his career with a bang by crashing the world's first jet aircraft. Today only ardent historians remember his name.

NASM



IT LIGHTS UP IN THE DARK!

Barnes and Noble Proudly Presents MERCURY—A World Class Illuminated Globe.



Turned off, the Mercury depicts land and ocean topography. Switched on, the political world, including current boundaries and international borders, is revealed in eight vivid colors.

A globe is like an encyclopedia or Bible—no educated home is complete without one. Maps are all very well and good, but only the *three-dimensionality* of a globe can accurately represent the shape and proportions of our planet—it's a 'hands-on' geographical learning aid the whole family can use.

And now your family can enjoy discovering a *new* world with the Mercury *Illuminated* Globe—an impeccably detailed, 18' tall model of our planet made in Italy by Nova Rico, the premier globe-makers of Europe.

Two Globes in One

Exquisitely designed and perfectly executed, the *Mercury* is actually two globes in one! Before you switch it on, it offers a comprehensive view of the earth's physical surface, including its topography, elevations, vegetation patterns, ocean currents plus latitude, longitude and international date lines as well as 3,600 place names—everything from the tallest peaks to the tiniest islands!

CREDIT CARD CUSTOMERS CALL TOLL FREE

1-800-228-3535

IN NEBRASKA 1-800-642-9606 24 HOURS—7 DAYS A WEEK

PRICE BREAKTHROUGH!

NOW ONLY $29.95

Suggested List $48.95

As if all that weren't enough, switch the *Mercury* on, and its illuminated surface takes on an entirely new dimension. Here you will see the political world—the most current national boundaries and international borders—revealed *in 8 brilliant colors!* Clearly, no conventional globe can match the unique, exciting appeal of the *Mercury*.

An Earthshaking Bargain

Now it's easier than ever to let the *Mercury* light up your home. Only Barnes & Noble is able to offer this outstanding globe—normally sold for $48.95—for the astonishingly low price of ONLY $29.95! Never before—and probably never again—will a globe of such high quality be offered at such a low price.

Special Features of the Mercury

- Solidly constructed of durable, washable polystyrene
- Eight vibrant colors for quick identification
- Includes 25-watt bulb, 6 ft. cord. All parts UL listed.
- Reinforced welding means your globe lasts longer
- A high-quality plastic meridian and a sturdy base
- Stands an impressive 18" tall

Don't Miss Out on This Great Offer

Have you put off buying a globe for your family or yourself? Or have you noticed that the globe you have now doesn't reflect the vast changes of recent history? If so, this is your opportunity to own a globe that is not only beautiful, but completely accurate and up-to-date as well. So don't delay—order yours today!

Barnes & Noble Unconditional Guarantee

You must be completely satisfied with every item you order from Barnes & Noble by mail, or you may return it to us, for a full refund.

Barnes & Noble
Booksellers Since 1873

DEPT.G472
126 FIFTH AVE.
NY, NY 10011

1430917. Please send me _____ Mercury Illuminated Globe(s) at your special sale price of only $29.95 (plus $3.00 each shipping and insurance). NY, NJ, MA, PA & MN residents please add applicable sales tax.

Name _____

Address _____ Apt.# _____

City _____ State _____ Zip _____

☐ Check ☐ Mastercard ☐ VISA ☐ American Express

Expiration Date Month/Year ☐☐☐☐

Credit Card Number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Signature _____

HIGH SOCIETY.

As the four Rolls Royce® engines ease you to Mach 2 and the Earth slips away, you realise flying need never be routine. But whatever British Airways flight you're on, rest assured you'll enjoy the height of courtesy.

BRITISH AIRWAYS
The world's favourite airline.®